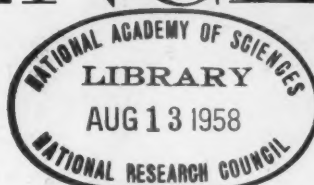


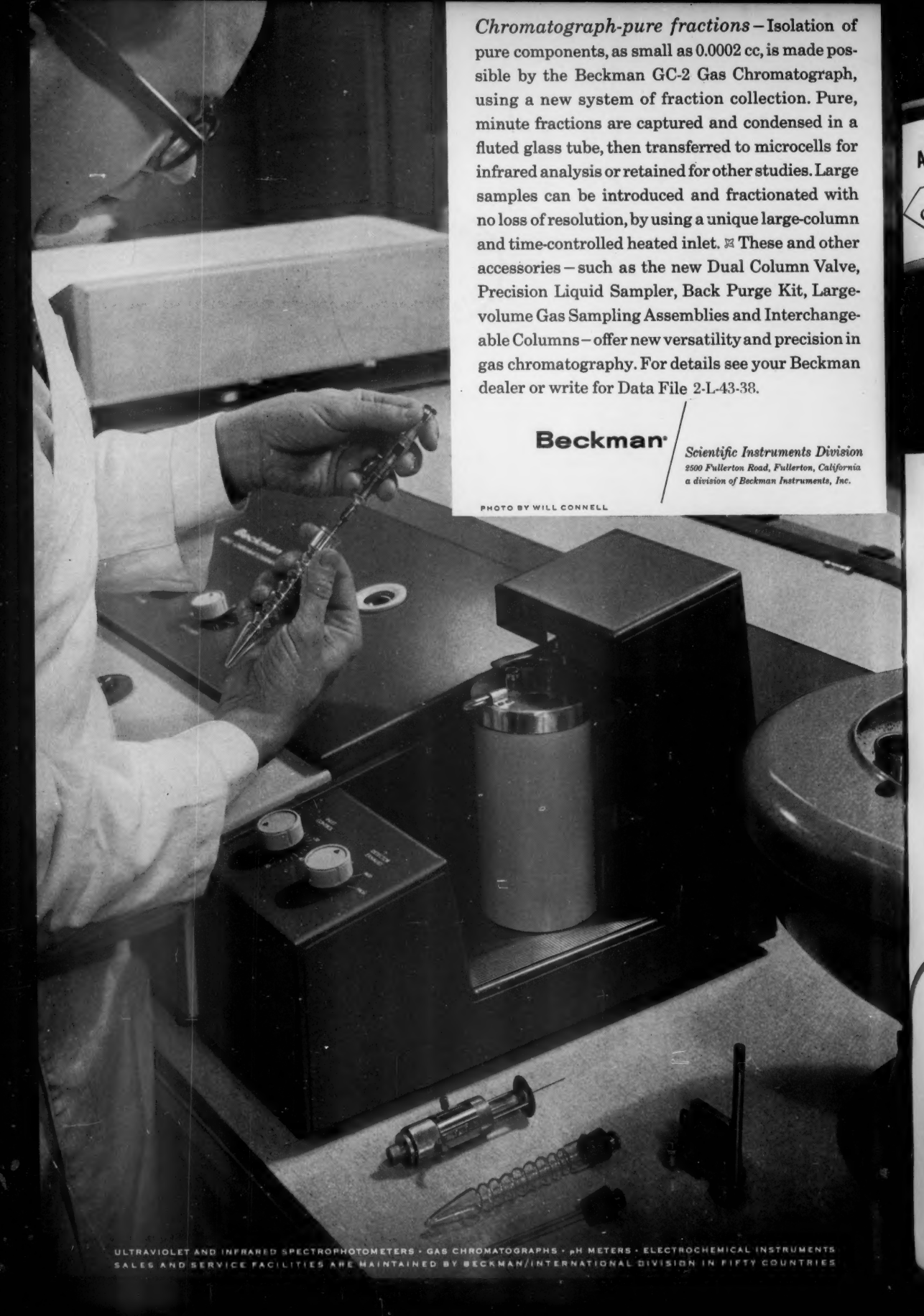
# SCIENCE

8 August 1958

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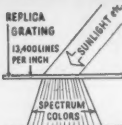


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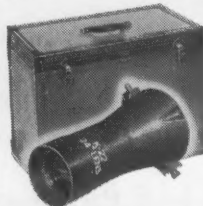
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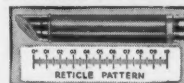
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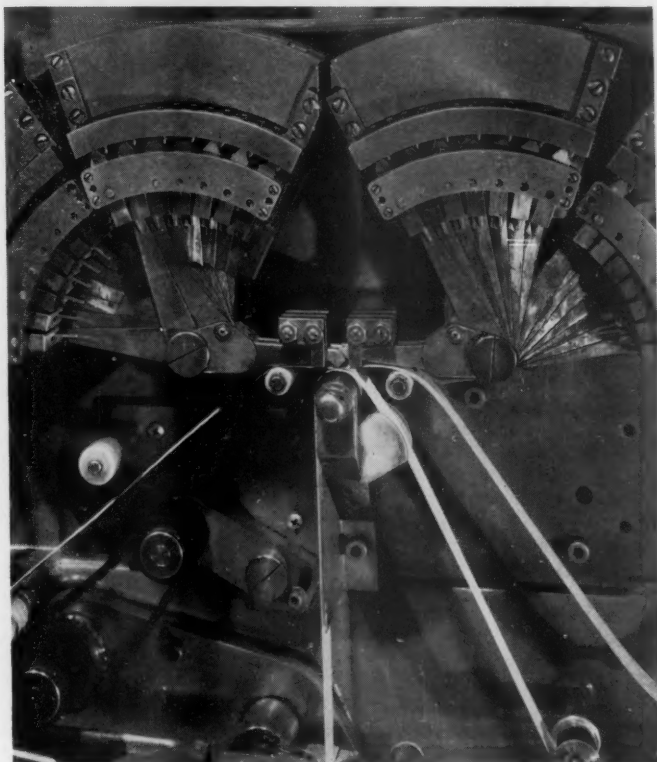
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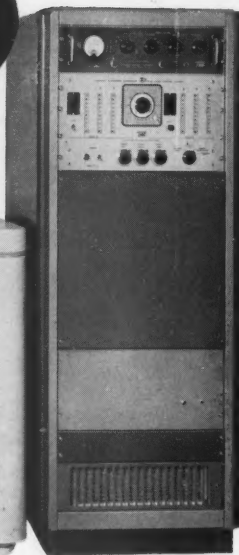
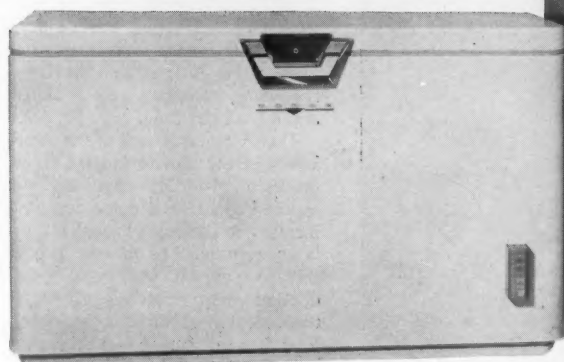
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## Who? What? Where?

If those agencies—either public or private—that make grants and contracts for research are to allocate their grants wisely and without duplication, they need to know about each other's activities. They need to know who is getting grants for what projects and where the work is being done.

Recognition of the need for this kind of information by the Government agencies granting aid for medical research led to the setting up of several information exchanges following the dissolution of the Office of Scientific Research and Development in 1946. The largest of these was the Office of Exchange of Information in the Public Health Service. As the number of grants and the amounts granted by Government and cooperating non-government agencies increased (from \$4.3 million in 1946 to \$33 million in 1949) the separate exchanges were consolidated, and the service was shifted to the National Research Council to simplify interagency support and was given a name that more clearly expressed its function, the Medical Sciences Information Exchange.

By 1953, the exchange was assembling information about awards that totaled \$56 million and had expanded into the fields of biology and psychology. For administrative reasons, the service was shifted again, this time to the Smithsonian Institution, and its name was changed to the Bio-Sciences Information Exchange to reflect its larger scope. The expansion of the exchange has continued: it now has registered with it some 17,000 active research projects; new grants for fiscal 1958 totaled 11,897, of which 9706 were made by Government agencies and 2191 by non-Government agencies; the grants totaled \$164 million, of which \$134 million was granted by Government and \$30 million by non-Government agencies.

The information offered by the exchange is obtained from an elaborate index—there are more than 6000 subject categories—based upon the reports of research projects prepared by investigators who apply for grants either to Government or the major non-Government agencies. The data so supplied are transferred to punch cards, and the information can be rapidly assembled according to whatever criteria are selected. Cooperating agencies, committees, and properly qualified individuals can obtain information from the exchange at no cost. Thus, before it expanded its activities into support of research in rheumatoid arthritis and congenital malformations the National Foundation for Infantile Paralysis could have obtained information about the total money currently granted for research in these fields.

Not the least interesting of the exchange's services is that available to the individual investigator. Every scientist has heard at least one sad tale about one of his fellows who was just about to ship off a manuscript only to discover that someone else had done his work for him. This is more than a source of distress for the individual scientist: it is a wasteful duplication of effort. A scientist interested in a particular subject may, even though he has no grant, register his project with the exchange. (About 3000 have done so this year.) He may also ask the exchange to give him the names and project descriptions of others working in the same specific field. The first step may lead others—granting agencies or individuals—to get in touch with him; the second gives him a chance to find out what others in his field are interested in and thus reduces his chances of duplicating work being done elsewhere.

The exchange invites cooperation. Inquiries should be addressed to Dr. Stella Leche Deignan, Director, Bio-Sciences Information Exchange, Room 1113, Dupont Circle Building, 1346 Connecticut Avenue, NW, Washington 6, D.C.—G.DuS.



Courtesy Mount Wilson Observatory

## FROM BEYOND THE SKY TO BENEATH THE SEAS

In the field of communications, two extraordinary events have occurred within a short span of time. One was the linking of Europe to America by the submarine telephone cable. The other was the sending of radio signals from U. S. satellites in outer space.

Both achievements depended on developments from Bell Telephone Laboratories. The cable was made possible

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## CURRENT PROBLEMS IN RESEARCH

## Ionic Vacuum Pumps

Instead of removing the particles of gas, some new pumps simply transfer them to the solid phase.

Lewis D. Hall

With the continued growth and refinement of high-vacuum techniques, there is an increasing interest in methods of obtaining high vacuums by means that will minimize the introduction of contaminants into the vacuum system. In addition, methods are being sought which will make it possible to obtain ultrahigh vacuums without the use of such auxiliary procedures as refrigerating the system.

The terms *high vacuum* and *ultrahigh vacuum* deserve some discussion. As in the case of the analogous terms *high purity* and *ultrahigh purity*, their meanings have changed considerably with time. Today, the term *high vacuum* signifies to most specialists pressures of  $10^{-5}$  mm-Hg or below, and *ultrahigh vacuum* pertains to pressures below  $10^{-8}$  mm-Hg (1). As pumping techniques have improved, pressures have been pushed to lower and lower values, and this in turn has led to further refinement of techniques. Those old standbys, the oil diffusion pump and the mercury diffusion pump, are beginning to be replaced in certain applications by devices which can be classified under the general heading of ionic pumps, or, more properly, electron-ion-neutral particle pumps.

As indicated above, the search for improved high-vacuum pumps has been motivated by two main factors: (i) the need for a fluidless pump which will not require a cold trap, in order to eliminate

contamination of the system caused by back-diffusion of the pumping fluid, and (ii) the need for a pump which will have a pumping speed greater than zero in the ultrahigh-vacuum region, in order that these extremely low pressures can be obtained without having to refrigerate the entire system. A third requirement, which is fulfilled by the class of pumps to be described here, is that of absence of high-speed mechanical motions.

The kinds of pumps that have been evolved to satisfy these demands are usually termed "ion pumps," because of the fact that the pumping mechanism depends in part at least upon the production of electrically charged particles, or ions. Some of these ion pumps depart radically from the intuitive definition of "pumping," in that gas particles are not pumped out of the system into the atmosphere, but instead are simply transferred from the gas phase to the solid phase inside the system. Such pumps are sometimes referred to as "getter" pumps because their pumping action is similar to the action of getters used to improve the vacuum in electron tubes. It is therefore convenient to generalize the term *pumping* to mean any process by which the number of molecules in the gas phase in the system is caused to decrease. This general definition will be used throughout this article. The term *cleanup* has also been widely used to denote a reduction in pressure caused by electrical or chemical effects, or both, in a sealed system.

## History

The earliest recorded observation of electrical pumping was made by Plücker in 1858 (2). Plücker stated that oxygen, chlorine, bromine, and iodine reacted with the platinum negative electrode in his discharge tube. The reaction products were then deposited on the glass walls of the tube, according to his interpretation. This view of the pumping mechanism is probably incorrect, in the light of modern knowledge; nevertheless it embodies certain of the phenomena which actually occur in gas cleanup.

An excellent review of the earlier work on gas cleanup in electrical discharge has been given by Pietsch (3). Dushman, in his classic treatment of vacuum technique, gives an extensive coverage of the field up to 1949 (4). Observations of electrical cleanup were made by many workers over a period of years before any attempt was made to apply the effects to make a vacuum pump. Pietsch alone lists 169 references, among the more interesting of which are Heald (5) and Soddy and Mackenzie (6).

The kind of apparatus in which cleanup effects were observed consisted in its simplest form of a glass tube with two electrodes, containing a gas at a reduced pressure. A typical tube of this kind, the Crookes tube, is shown in Fig. 1.

From the beginning, it was generally recognized that for gas to be pumped electrically some or all of the following phenomena must occur: (i) ionization; (ii) excitation, that is, dissociation of molecules into atoms and creation of metastable molecules; (iii) sputtering, that is, removal of material from a cathode surface by positive ion bombardment; (iv) chemical or physical reactions of gases with the electrodes; (v) chemical or physical reactions of gases with disintegrated (sputtered) cathode material; and (vi) chemical or physical reactions of gases with the container walls.

The combination of these effects into a device that would serve as a useful

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pump has been a long time in coming, but developments have been accelerated in the past few years.

### Modern Ionic Pumps

One of the most important single developments in the history of ionic vacuum pumps occurred when Penning developed the technique of a cold-cathode discharge in a magnetic field (7). Penning's aim was to produce a device which could be used to measure pressure, and the degree to which he succeeded is shown by the widespread use of his gauge today. The Penning gauge, or Philips gauge, as it is called in this country, uses a high-transparency anode, solid cathodes, and a magnetic field which greatly increases ionization.

Figure 2 shows the Penning gauge as depicted in his original patent (8). Electrons which originate anywhere in the volume tend to go to the ring-shaped anode, but are constrained by the magnetic field, about which they spiral and produce other electrons by various processes, directly and indirectly. Because of the magnetic field, which need be only a few hundred oersteds, the discharge persists down to much lower pressures

than it otherwise could. One of the concomitant effects observed in the Penning gauge is a reduction in pressure in the gauge due to removal of molecules from the gas phase. This was recognized by Penning and others as a drawback to use of the gauge to measure pressure (7, 9). It is obvious that to the extent that a gauge acts as a pump, thereby perturbing the system, it cannot be considered as an absolute standard for pressure measurement.

The use of a magnetic field and an anode which is highly transparent in the direction of the field are powerful aids to the development of a useful ionic vacuum pump. It was not until several years after Penning's invention, however, that a vacuum pump of appreciable speed was developed, based on a discharge in a magnetic field. The first large vacuum pump of this kind was developed by Foster, Lawrence, and Lofgren (10).

The essential features of the Foster pump are shown in Fig. 3. Gas is removed from the central section, which is the high-vacuum region, and delivered to the exit sections, which are at higher pressure. The primary electron source is a hollow, hot cathode at one end, which consists of a helix wound

with heavy tungsten wire or rod. A discharge is created which is collimated by the magnetic field and extends from the hot cathode to a cold reflecting cathode at the other end. Electrons emitted from the hot filament attempt to go to the walls, which are at anode potential, but are constrained by the magnetic field to travel in spirals back and forth along the tube. As the electrons oscillate, they lose energy by collisions until they are finally collected on the anode walls.

The positive ions which are created in the discharge are little affected by the magnetic field, but are attracted to the cathodes. Some of these ions may combine with the cathodes; others may be neutralized and then pumped out by the forepump. Other processes can occur, such as trapping of neutral particles by material which is sputtered from the cathodes and deposited on the walls.

At low pressures in the central region of the pump, the positive ion supply is insufficient to maintain a discharge of the desired characteristics, and it is necessary to introduce gas through a leak into the cathode region. This gas leak is adjusted to keep the pressure in the hot cathode region above  $3 \times 10^{-4}$  mm-Hg. The pump is usually operated with an exit pressure of  $3$  to  $5 \times 10^{-4}$  mm-Hg. The lowest central pressure may vary from  $0.8 \times 10^{-6}$  to  $6 \times 10^{-6}$  mm-Hg. The pumping speed is reported to be 3000 to 7000 liters per second.

Some of the disadvantages of the Foster pump are its large size, high initial cost, high power requirements, and short cathode life. Several thousand amperes are required by the magnet coils, and pump life is severely limited by deterioration of the hot tungsten cathode due to positive ion bombardment. Because of these limitations, its use has been confined to certain experiments with particle accelerators.

A pump which appears to be of much more general utility than the Foster pump was developed by Herb, Davis, Divatia, and Saxon (11) and described in detail by Davis and Divatia (12) and by Swartz (13). The Herb pump, or Evapor-ion pump, as it is usually called, is shown in Fig. 4. It utilizes evaporation of titanium, continuously or intermittently, in conjunction with ionization. The pumping action consists in trapping gas particles on the titanium-coated walls.

The metal casing is 12 inches in diameter and about 24 inches high. The connection to the vacuum system may be made at either end of the pump; in Fig. 4 it is connected to the top. The roughing pump may be connected

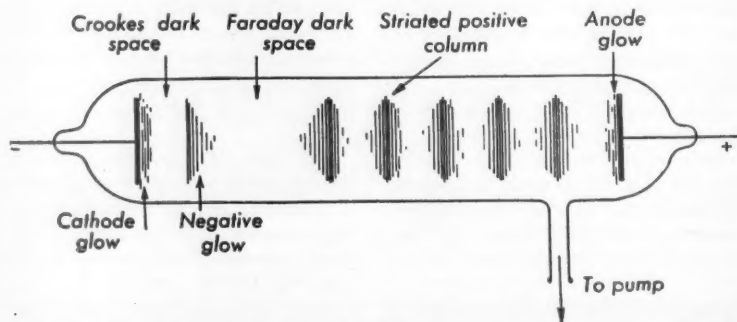


Fig. 1. Crookes gas discharge tube. [From H. Semat, *Introduction to Atomic and Nuclear Physics* (Rinehart, New York, 1954). Courtesy Rinehart & Co., Inc.]

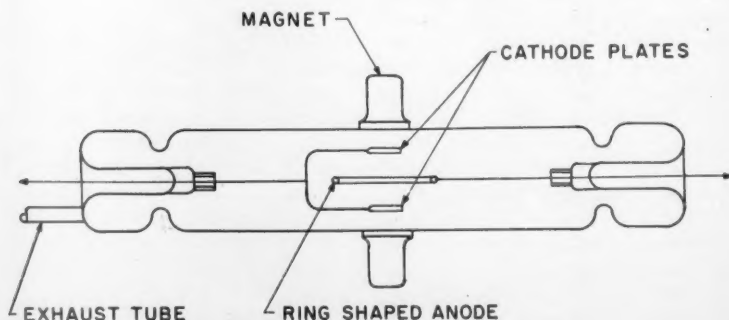


Fig. 2. Penning cold-cathode ionization gauge.



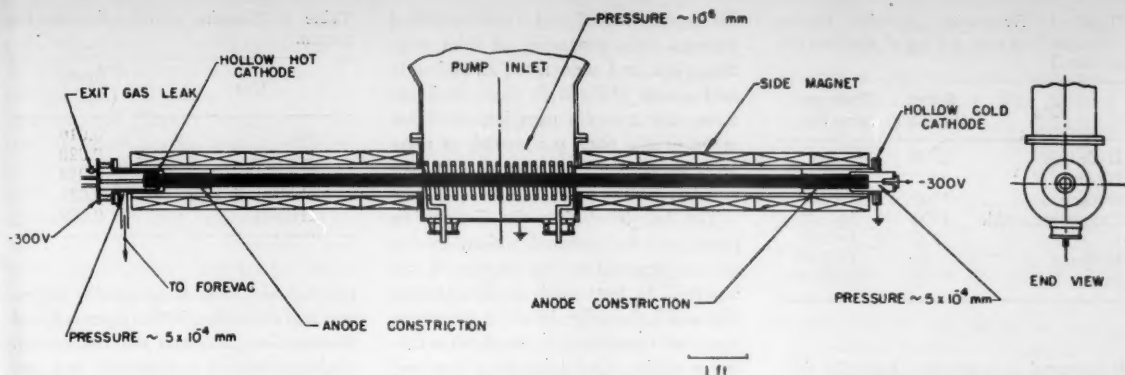


Fig. 3. Foster ion pump.

through a valve either directly to the vacuum chamber or to a 4-inch opening (not shown in Fig. 4) on the side of the Evapor-ion pump. When the Evapor-ion pump is in operation, the valve in the roughing line is usually closed.

A spool of titanium wire is located in the top of the pump. The free end of the wire passes through a feeding mechanism and a tube which guides the wire onto a hot metal post. The feed is actuated through a metal bellows by an external motor. The post is heated by the bombardment of electrons from a single-loop tungsten filament which encircles it. When the wire touches the post, the end melts and also evaporates, coating all exposed pump surfaces. The fresh coating of titanium readily getters active gases such as nitrogen, oxygen, hydrogen, and the carbon oxides. Pumping of the noble gases, such as helium and argon, is believed to require ionization, but this aspect of the pump's behavior requires further investigation. It is certain that a discharge is necessary, but the role of the discharge is by no means fully understood. Electrons for the discharge are furnished by the tungsten filament.

The post and grid are operated at potentials of the order of 1000 volts, and it is therefore necessary to rough out the pump and system to a low pressure, of the order of  $5 \times 10^{-5}$  mm-Hg or below, before attempting to start operation. If this is not done, positive ion bombardment will cause rapid deterioration of the tungsten filament. The problem of establishing favorable conditions for starting the Evapor-ion pump is not simple, and considerable effort has been expended in the direction of making these conditions less severe. The problem is of importance because the ultimate vacuum of a good mechanical roughing pump is of the order of  $10^{-3}$  mm-Hg.

A method of varying the grid potential so as to localize the ionization during starting has been proposed by Moenich, Otavka, and Weberg (14). In this technique, the grid, which is ordinarily positive, is reversed in polarity, so as to be negative with respect to the filament. The electrons are driven toward the post rather than accelerated outward into the large volume of the pump chamber. The glow discharge is thus reduced in vol-

ume; consequently, less energy is dissipated in maintaining it, and the post is heated more rapidly. In addition, ion bombardment of the filament per unit time should be less severe, because of the smaller extent of the glow discharge. Moenich *et al.* have made another change by adding an extra grid of approximately the same diameter as the filament. This grid is positioned around the post and midway down its length. It

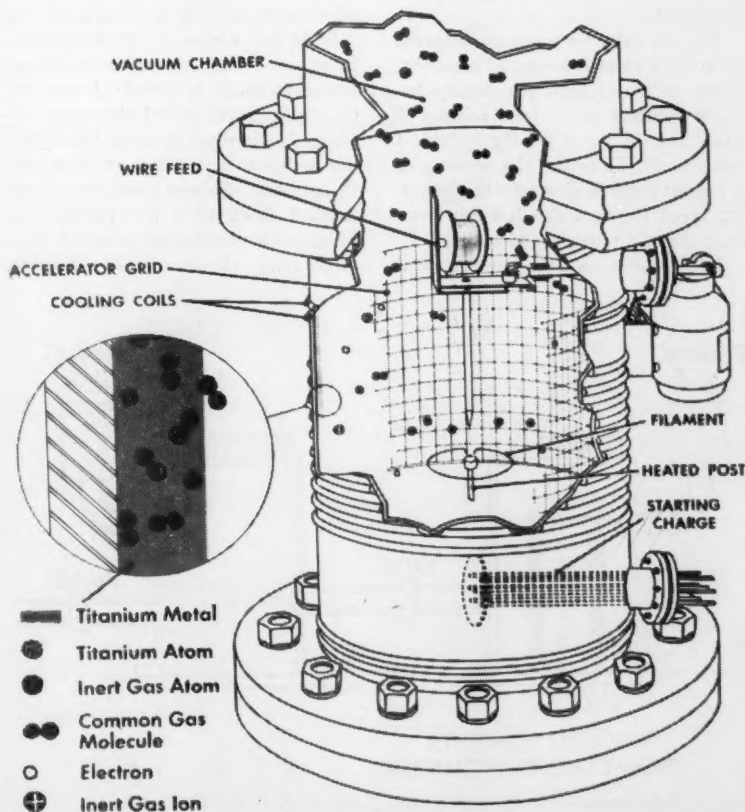


Fig. 4. Evapor-ion pump.

Table 1. Evapor-ion pumping speeds. (Evaporation rate, 5.3 mg of titanium per minute.)

Gas	Speed (lit./sec)	Pressure (mm-Hg)
Hydrogen	3300	$1-7 \times 10^{-6}$
Nitrogen	2000	$3 \times 10^{-6}$
Oxygen	1000	$1 \times 10^{-6}$
Carbon monoxide	1000	$5 \times 10^{-6}$
Air	370	$1 \times 10^{-6}$
Methane	20	$1 \times 10^{-6}$
Argon	5	$5 \times 10^{-6}$

is operated at a negative potential during starting and shields the lower portion of the pump elements from electron bombardment. According to Moenich *et al.*, this modification and that of decreasing the filament diameter have made it possible to start from a rough vacuum of as high as  $5 \times 10^{-3}$  mm-Hg. These changes have not yet been incorporated in commercially available pumps.

Swartz has measured pumping speeds of the Evapor-ion pumps for some common gases, using Dayton's constant-pressure method (15). Values are summarized in Table 1, together with the pressures at which the measurements were made.

The low value for argon as compared with active gases is worthy of comment. There is a reciprocal relationship between pumping speeds for a mixture of gases and the speed for the individual components. Therefore, the presence of 1 percent argon in air results in a pumping speed for air which is much lower than that for nitrogen and oxygen.

In order to increase the pumping speed

for argon, Alexeff and Peterson added external coils, producing an axial magnetic field, and constructed an elaborate grid system (16). With these modifications, they report a pumping speed for argon of 250 liters per second, at pressures between  $2.5 \times 10^{-6}$  and  $2.5 \times 10^{-5}$  mm-Hg.

The length of time the Evapor-ion pump can be operated without maintenance depends on the amount of gas pumped. In tests made at Brookhaven National Laboratory, in which the pump was used to evacuate a simulated accelerator section, Gould estimates that one might expect 2000 days of operation before having to shut down to replace a spool of wire (17).

The Evapor-ion pump is an interesting and potentially very useful device. At present the principal obstacles to its widespread acceptance are its high cost and the high cost of associated mechanical pumping equipment which is necessary for most applications. Because of the relatively high vacuum required for starting, only combinations embodying Roots blower mechanical pumps are feasible, and these are quite expensive. However, it is possible that future research of the kind described above may alleviate the starting problem (14).

Since the advent of the Evapor-ion pump, small titanium evaporator pumps have been made in several laboratories. One such pump, called the getter-ion pump, is described by Gale (18). Figure 5 depicts this pump on a system. In operation, the pump and system are roughed down to a few microns, at which point the filament is heated, thus evaporating titanium. The Penning

Table 2. Pumping speeds of getter-ion system.

Gas	Speed (lit./sec)
Air	0.016
Oxygen	0.028
Nitrogen	0.018
Carbon dioxide	0.024
Helium	0.009

gauge, which is used to provide ionization and excitation, is then operated, and the combined action of evaporation and discharge reduces the pressure to a low value, of the order of  $10^{-6}$  mm-Hg or below.

An interesting feature of such a pump is its ability to pump noble gases. As Gale points out, it is difficult to account for this pumping by the usual explanation that atoms are ionized and then accelerated and imbedded in the getter surface. In this pump, the ionization regions do not "see" the getter surface, and pumping of the noble gases occurs even when an atom must make at least four contacts with the walls before it reaches the getter surface. This therefore suggests that the comparatively long-lived excited states of the neutral atom are important. Pumping speeds for the getter-ion pump are given in Table 2.

My experiments in this laboratory have led to the development of an ionic ultrahigh vacuum pump. The motivation for this work was the desire to develop a small, compact ionic vacuum pump which could be used to replace conventional oil diffusion pumps in the processing of microwave vacuum tubes. Such a pump would have to have a reasonable pumping speed, but speeds of greater than a few liters per second are not required. This is because the limiting factor in tube processing is almost always the impedance represented by the internal structure of the tube and the tubing used to connect it to the vacuum pump.

Experiments with getter-ion pumps were continued for several months in an effort to develop a modification which would be suitable for processing microwave tubes. In the course of this work, several metals were used as evaporants. Of these, titanium, a titanium-manganese alloy, and chromium proved to be effective. However, the useful life of this pump was severely limited by early burnout of the evaporative filament (Fig. 4).

At the same time, experiments were being carried on for another purpose, unrelated to the pumping problem. In the course of this work, which involved

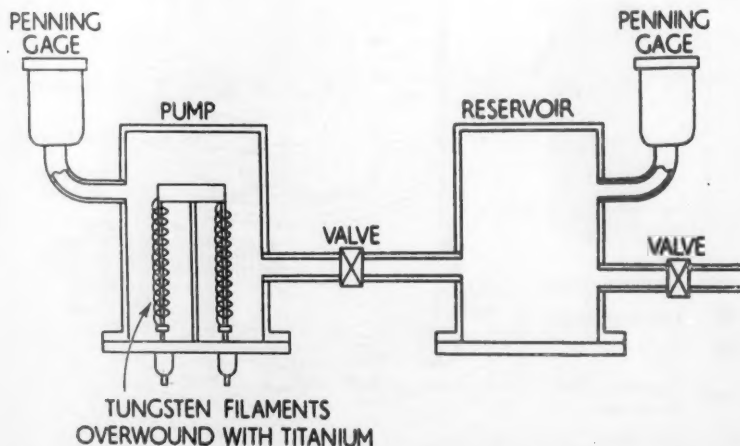


Fig. 5. Gale getter-ion pump and system. [From A. J. Gale, "Cold sealed getter ion pumped superevoltage x-ray tubes," in *C.V.T. Vacuum Symposium Transactions* (Peragamon, New York, 1956). Courtesy American Vacuum Society and Peragamon Press.]

cathode sputtering, it was observed that gas cleanup occurs during sputtering—the same cleanup which had been reported by so many workers over the past hundred years. Since sputtering had also been observed in the Penning ionizer which was appended to the getter-ion pump, a different approach was conceived, and a pump was developed in which the functions of evaporator and ionizer are combined. This pump, shown in Fig. 6, employs a cold-cathode discharge with cathode plates of a reactive metal. Titanium, molybdenum, magnesium, and aluminum are typical cathode materials, and other metals such as vanadium and the rare earths can be used.

Pumping occurs when gas molecules and atoms are taken "out of circulation." The design of an ionic vacuum pump therefore depends on the method by which gas particles are to be trapped. The design of most earlier pumps has been such that the primary pumping action is ascribed to a single cause, the burial of ions in cathode surfaces, although it has been recognized that sputtering may account for some of the observed effects (7, 19, 20).

In developing the pump shown in Fig. 6, the intent has been to utilize as fully as possible four interrelated phenomena—ionization, excitation, sputtering, and gettering—in order to produce a pump of much greater speed, lower ultimate pressure, and longer life. It was felt that only by making use of all these effects could a small pump be constructed which would have satisfactory pumping speed for a variety of applications combined with very low ultimate pressure and long life. These properties are aided considerably by designing for maximum gettering, rather than for ion burial.

The discharge creates positively charged particles (ions), atoms (dissociated molecules), and metastable atoms and molecules. High-density parallel ion beams defined by the individual cells bombard the cathodes, ejecting cathode atoms. These sputtered atoms are deposited on appropriately chosen surfaces—the anode walls, and, to a much smaller degree, on the opposite cathode. Atoms and metastable particles which in their random motion strike the sputtered deposits will be trapped by chemical or physical bonds and firmly held. This constitutes the gettering or pumping action.

It is apparent from the data on earlier pumps that ion burial and sputtering are not enough in themselves to provide the desired pump characteristics. To this

end, all four of the afore-mentioned effects must be properly integrated. For example, sputtering per se is quite ineffective unless it results in the proper distribution and location of sputtered deposits. The sputtered material must be deposited on appropriately oriented surfaces at anode potential in order to getter properly. Moreover, the density of the ion beam is quite critical, and depends strongly on anode configuration. Neither a ring nor a simple cylinder provides adequate ion current density (concentration over a small area) to compensate effectively for the current of gas particles which continuously arrives at the cathode as a result of random molecular motion. In order to sputter cathode atoms, the ion beam must be dense enough to compete with the molecular beam which tries to keep the cathode covered. On the other hand, if the ion beam is too intense, local melting of the cathode material may result. The cell design is therefore critical.

The cellular anode (Fig. 6) has been found to have many advantages over a ring or a simple cylinder. It increases the effective gettering area, thus increasing the probability of trapping gas particles, and provides increased surface in close proximity to the discharge. This

promotes the trapping of excited particles (atoms and metastable particles) before they can recombine into stable states which are less readily getterred. The increased surface area is also of great value in spreading out the getter deposits as widely as possible, thus minimizing the flaking which occurs after long service. It intercepts sputtered atoms, which are thenceforth at anode potential and cannot be resputtered. It increases the effective area of cathode surface from which sputtering occurs, and greatly increases the ion current density, thus further increasing the sputtering rate. It provides a large number of deep field-free regions, increasing the proportion of high-energy ions and thereby increasing sputtering. In addition, it increases the total ion current at any given pressure and permits the discharge to persist to indefinitely low pressures at the applied voltage of 3 kilovolts. The latter feature insures that the pumping speed will not fall to zero until extremely low pressures are reached, since the discharge is responsible for the sputtering which provides the gettering material. It has thus been possible to reach a pressure of  $2 \times 10^{-10}$  mm-Hg after a short bake-out.

Pumping speeds for several gases have

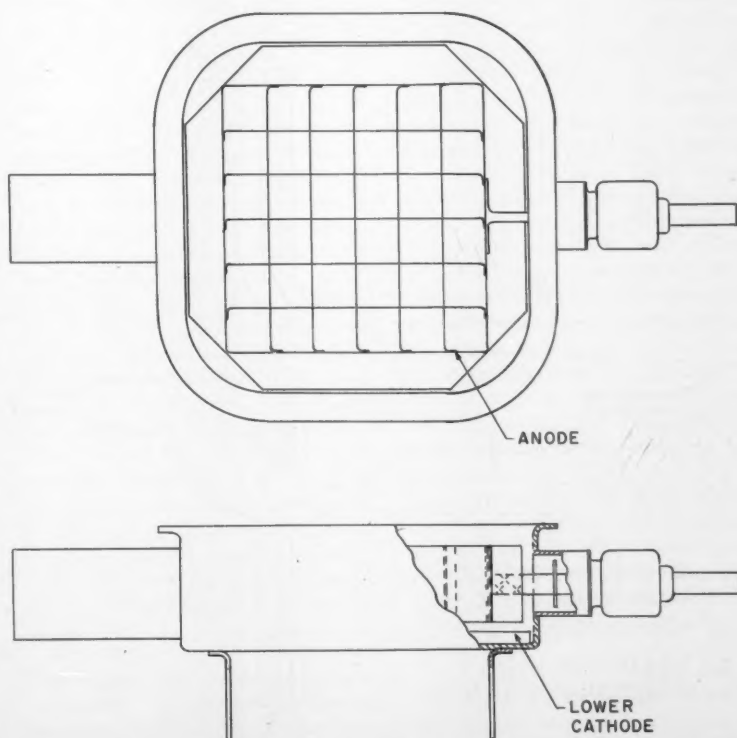


Fig. 6. Varian VacIon high vacuum pump.

Table 3. Varian pump characteristics.

Pressure (mm-Hg)	Speed (lit./sec)	Time to start (min)
<i>Room air</i>		
$1 \times 10^{-7}$ to $1 \times 10^{-8}$	10.5	1 to 3
<i>Hydrogen</i>		
$2 \times 10^{-7}$	11.5	1 to 3
<i>Argon</i>		
$2 \times 10^{-7}$	9.0	10
<i>Helium</i>		
$3 \times 10^{-7}$	10.0	10

been measured for a voltage of 3 kilovolts and a magnetic field of 1200 gauss. The measurements are summarized in Table 3, which also gives the starting time—that is, the time required to reduce the pressure in a small system from “rough vacuum” to  $2 \times 10^{-4}$  mm-Hg. Varying the magnetic field over a wide range has little effect on pumping speed.

The ultimate life of the pump will be limited by the supply of cathode metal, and, in this connection, the economical use of titanium which has been observed is of interest. It has been found that in pumping such gases as air, carbon diox-

ide, and hydrogen, approximately  $\frac{1}{2}$  to 1 gas molecule is pumped for each atom of titanium sputtered.

An ionic vacuum pump of considerable interest has been developed by Tsukakoshi (21). The Tsukakoshi pump is designed to provide oilless pumping at pressures below  $1 \times 10^{-6}$  mm-Hg, at which the speed of an oil diffusion pump falls off sharply. The pump, shown in Fig. 7, together with an appended ion gauge for pressure measurements, consists essentially of a source of evaporated barium and a hot cathode discharge in a magnetic field. Tsukakoshi does not discuss the ultimate vacuum attainable with this pump, but he gives pumping speed values for several gases. These are summarized in Table 4.

#### Future Trends

From the accelerated development of ionic pumping devices in the last few years it is evident that we are witnessing the growth of a promising new technology. Pumps have now been built which can compete with oil and mercury diffusion pumps in many respects and which

Table 4. Tsukakoshi pump speeds.

Gas	Speed (lit./sec)	Pressure (mm-Hg)
Oxygen	80	$3 \times 10^{-7}$
Carbon dioxide	50	$1.2 \times 10^{-7}$
Water vapor	26	$2.5 \times 10^{-7}$
Hydrogen	8	$2.5 \times 10^{-8}$

can replace them for some applications.

At this stage it is difficult to predict the possible future form of the ionic vacuum pump. However, it is intriguing to speculate about the directions in which changes might occur. For example, it would be desirable from the standpoint of life to expel gas particles to a region outside the pump in such a way that they could not return. This would eliminate saturation effects. Such a design would require some sort of “one-way valve” for gas ions, through which they could pass to the outside but could not return. An experiment along these lines was performed in this laboratory. A bundle of small-diameter tubes with the axis of the bundle aligned with the axis of the anode in a Penning-type pump was used. It was hoped that in this way, ions would pass through the tubes at a much greater velocity than that with which molecules would drift back. The region outside was pumped with a mechanical pump. The experiment was a failure, for various reasons, but it is felt that the approach may yet yield results. In considering any such ion-ejection system, however, it should be remembered that in an “open” system of this kind, one of the chief advantages of a sealed-off pump is lost—namely, invulnerability in the face of a power failure.

A future ionic pump of the evaporative- or sputter-type may use some metal which is even more reactive than those presently available. It has been reported by Hum that gadolinium shows a much faster pumping effect than other metals in vacuum evaporation (22). Unfortunately, the present price of gadolinium metal is prohibitive.

It seems certain that the ionic vacuum pump of the future will employ a magnetic field as well as an electric field, because of the much greater ionization and excitation which are produced. It seems quite probable that, as indicated by present trends, many different designs will emerge, each with its own range of applications. The future of ionic vacuum pumps, like that of ion propulsion and magnetohydrodynamics, appears to be filled with attractive possibilities.

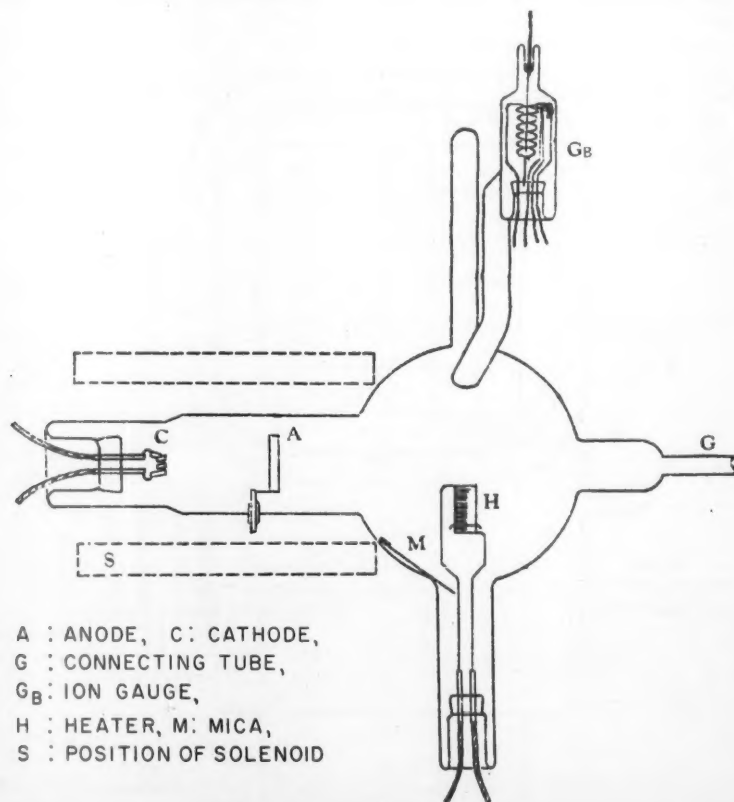


Fig. 7. Tsukakoshi ion-barium pump.



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# Role and Status of Anthropological Theories

How successful has anthropology been in producing its own theories? or even in borrowing them?

Sidney Morgenbesser

The progress of anthropology in the last hundred years has evoked, even from critical observers of the state of the social sciences, well-deserved admiration (1). Developments in data collection and interpretation, subtle employments of logical and mathematical techniques, a spate of monographs that tax the patience even of the most Alexandrian of librarians, all prove that the phrase "a trained anthropologist" is not a contradiction in terms.

Despite these advances, it is debatable whether the theories employed by anthropologists need win our assent. Concomitantly, it is questionable whether such terms as *culture*, *cultural integration*, *role*, and others which appear in such theories are as indispensable for a proper explanation of societal factors as many anthropologists claim.

The first point to note is that there is no universal agreement among anthropologists about the role and relevance of any of the theories currently employed. There is even room to doubt whether anthropologists have any theories at all. British anthropologists have insisted that the concept of social structure introduced by Radcliffe-Brown (2), developed by Evans-Pritchard, and now the subject of an interesting monograph by the late and

too-little-read S. F. Nadel (3) provides them with a rock upon which to build. But a concept is not a theory. Many American anthropologists, moreover, find that Radcliffe-Brown's statements are either opaque or are merely developments of some trite sociological points that Durkheim made long ago (4). Not to be outdone in gallantry, British anthropologists find American theoretical anthropology to be either an obsession with the workings of a mystic entity labeled "culture," or applied psychology (5). Lest the reader think that I am recording a series of transatlantic insults, I shall quote the words of a long-respected American anthropologist, provoked by an anthology of American anthropological writings: "Some two generations ago," writes Paul Radin, "the great English legal historian (Maitland) declared that anthropology would very shortly have to choose between being history or nothing. Maitland was wrong. . . . Anthropology did not become history, nor did it ostensibly become nothing. In fact, it became everything, and seemed to have taken its etymological meaning literally" (6).

These four notes serve a function. They suggest that it would be helpful to consider anthropological theories under two headings—psychological ones employed by American, and sociological

ones employed by British, anthropologists. Since there are Americans in the English camp, and Britishers in the American, this division should not be taken too seriously.

The employment by anthropologists of psychological theories, especially of learning theory (7), might evoke surprise.

## Uses of Learning Theory

A score of years ago the journals were replete with articles attempting to establish the independence of the social sciences in general, and of anthropology in particular, from psychology. Some merely insisted that cultural data cannot be accounted for on the basis of psychological principles alone. Others went further and suggested that anthropologists disregard the findings of psychology and direct their attention to the interaction of biological and cultural phenomena. Still other articles, like Kroeber's, seemed to suggest that culture is a unique superorganic entity with laws and properties of its own. Culture was the hero and psychology the villain of the drama, and not to anthropologists alone. In a famous chapter in *Experience and Nature*, John Dewey suggested that philosophers test their theories of human nature in light of the teachings of anthropology about culture and its influence. As the writings of Leslie White prove, such themes have not entirely disappeared from the literature of anthropology (8). But they are much rarer. Today more anthropologists couple the term *culture* with the word *learned*, or one of its cognates, or else drop the term *culture* and refer merely to "learned behavior." And since learning theory is part and parcel of the science of psychology, we have, despite earlier protestations, not merely an alliance between anthropology and psychology but a threatened domination of the former by the latter.

This turn of events is not too hard to explain. When anthropologists criticized the relevance of psychology, they were primarily refuting the thesis that infor-

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mation about mental or private phenomena will account for behavioral data, and they thus identified psychology as the science of the mental. Critiques of this version of psychology, however, are ineffective against the type of behaviorism which many defenders of current learning theory uphold.

Learning theory has some decided advantages. It deals with acquired dispositions to behave, and if its scope can be shown to encompass all cultural phenomena, then mysteries about the ontological nature of anthropological subject matter will disappear. One need no longer worry about the status of culture in contradistinction to that of the individual and need no longer pose questions about the relationships of the individual to his culture. Cultural phenomena are shared acquired dispositions, all of them dispositions of specific human beings.

Learning theory also provides a set of interlocking propositions about the mechanisms for the acquisition of dispositions and thus affords anthropologists an escape from silence. For the truth of the matter is that anthropologists, despite their persistence, have never been explicit about the conditions under which habits are acquired, and thus about the conditions for cultural transmission. Moreover, learning theory holds forth promise of being a more basic theory than any of the Freudian theories that are available. For, suggestive as Freudian doctrines are, they are primarily devoted to an explanation of the development of personality traits and structures. Such traits are acquired, hence learned, and hence are part of the subject matter of learning theory (9).

It is, of course, not only to the analysis of the term *culture* that behavioristic learning theory is relevant. Anthropologists as well as sociologists fill their pages with references to vague entities, such as roles, institutions, and social structures, that ostensibly influence and mold behavior. Quite frequently the statements about institutions, for example, are informative, and do not reflect belief in shadowy entities that cause and direct human action. Nevertheless, many of these statements are metaphoric and not explicit enough for scientific purposes. Learning theorists, by emphasizing the importance of discussing specific human beings and their traits, behavior, and dispositions, frequently introduce much needed rigor into social science writing.

Finally, learning theory, by lending itself to experimental confirmation, indicates a continuity between the meth-

ods of the natural and social sciences, and provides ground for the hope that the latter may some day be as successful as the former. Some may think it absurd to expect that experiments on rats, chimpanzees, and college freshmen will provide conceptual tools for the analysis of complicated social structures. But, a priori, it is no more strange to expect that than to predict that rolling balls on inclined planes will illuminate the paths of the planets and the movements of the stars.

### Limitations of Learning Theory

Despite these virtues, it is debatable whether the employment by anthropologists of learning theory has always been beyond reproach. Learning theory is a category term. There are many learning theories—Hull's, Guthrie's, the Gestaltists'—among which the anthropologist must choose. Frequently anthropologists have opted for Hull's "need-reduction" theory of learning, as if there were no legitimate doubts about its rigor and empirical confirmation. But on both counts Hull's theory has been found wanting, with the result that anthropological texts which depended upon Hull seem in retrospect naive and uncritical.

Even granting Hull's theory of learning and kindred conditioning theories one may still cavil at the statements which anthropologists make on the basis of such theories. For anthropologists and, it may be said, social psychologists have frequently converted the thesis that all learned dispositions may be due to the satisfaction or reduction of human needs to the proposition that all acts result from the attempt, either on a conscious or unconscious level, to reduce needs or tensions concomitant upon their unsatisfied presence. The acceptance of the latter proposition has led to much uncritical theorizing, of which the following is typical: "Suicide," writes John J. Honigman, "is a means for overcoming perplexing problems and anxieties, and it reduces a variety of tensions, but in doing so it also kills the person" (10).

Then again, anthropologists have frequently confused the triviality that most adult actions have a learned component with the dubious thesis that all adult behavior or action is simply learned and that a theory of learning may account for all such action. It is, of course, in light of his previous learning that a chess player decides upon a move, but it would be silly to think that all chess moves are

merely learned and that we would be able to deduce a chess player's moves simply from information about his previous "reinforcements." At least some information about his perceptions and expectations would be relevant. And, it may be added, to the theory of perception and cognition, learning theory of the Hullian type has thus far made no major contribution.

There are chess players who play chess by rote and never make a creative move, or even realize when they are confronted by a challenge. If all members of primitive societies resembled this type of chess player, it would perhaps be not too misleading for anthropologists to rely so heavily on conditioning theory. But anthropologists, especially at the beginning of this century, had undermined the contrast between primitive cultures, which are ruled by custom, and complex societies, which require and demand complicated decisions. They had emphasized that challenges and creative responses mark simple as well as complex societies. About such responses, it would be naive to insist that they were only learned or conditioned, although they are caused, and previous learning and conditioning are part of their causes.

Some of these difficulties will doubtless be avoided through sophisticated uses of an improved learning theory that is integrated with other psychological theories. But even in a refurbished form, learning theory, like any theory, cannot be directly applied but requires supplementary information which it does not explain. To fix our ideas, let us examine a relatively naive use of learning theory. A psychologist, wanting to explain the proverbial Jewish love for learning, appealed to the well-known fact (sic) that all Jewish mothers put honey on books and then induce the youngsters to taste the sweetened tomes. A few applications of conditioning theory, and psychologists would have the appendix to Bialik's "HaMasmid"!

This licking theory of learning has its advantages but leaves unexplained why Jewish mothers and not Albanians engage in such nefarious practices. At the risk of circularity we cannot insist that it is part of the Jewish culture to do so, and it would be evasive to say that Jewish mothers do what they do because their mothers did so before them. At some stage we would have to appeal to some historical explanation, and it is doubtful whether psychological theories alone, much less learning theory alone, suffice for such explanations.

## Societies as Integrated Units

Reduction of his theories to those of psychology does not prevent the anthropologist from devoting himself to other tasks, of which the paramount one has been the depiction of the interrelationships between elements of distinct cultures. Frequently such descriptions have resulted in monographs that, like the recent one by Francis Huxley on the Urubu Indians of Brazil (11) are interesting but devoid of theoretical concern. In the case of such thinkers as Malinowski, Benedict, Opler, and others, concentration upon distinct cultures as integrated units has fathered a school of thought about such cultures and about primitive societies.

The importance of these scholars in general, and of Malinowski in particular, must be acknowledged. They were sensitive observers and effective writers, setting high standards for both field work and publication. Their criticisms of naive evolutionary theories, of uncritical studies of cultural diffusion, and of dubious attempts to compare cultures, were instructive and emphasized the importance of concentrating upon the life of a people as a whole. Finally, by presenting theses not about individuals but about groups, societies, and other collectivities, they offered examples of theories which, *prima facie*, are independent of psychology and thus indicated another limitation to the learning theory approach to anthropology.

The significance of this school may easily be overestimated. Some of the criticisms by its members, especially of evolutionary views according to which societies have uniformly evolved from the simple to the complex, were not original, similar criticisms having been made earlier by Boas and others. Other aspects of their criticisms were unclear, for the criticisms rested upon misapplication of the postulate that the same institution in different cultures means different things. It was in light of this postulate that they criticized not merely naive evolutionary views and uncritical applications of the comparative method but any attempt to find laws about institutions which hold true in all or most cultures. But a law about marriage, for example, is not a statement about every one of its aspects but simply a proposition about its relationship to at least one other cultural or biological factor. To admit that every *A* is associated with *B* does not entail the hypothesis that all *A*'s are identical, nor does it deny the thesis that differences

among the *A*'s might be accounted for by reference to the contexts in which the *A*'s appear. Hence, no anthropologist need be suspended, like Buridan's ass, between the hay of admitting with Malinowski that no two manifestations of the same cultural unit are identical and the hay of searching with the Yale school for traits that are associated in all or in a statistically significant number of cultures.

The major limitation of this school, however, is that it is not a school. Though Malinowski, Benedict, *et al.* used common language and collectively engaged in bootless rhetoric against vague theories to the effect that cultures are heaps, or sums, or bundles, of traits, they did not offer common theories. They used terms like *integration* and *whole* differently, and they offered hypotheses that differed in range and significance.

Benedict's thesis is perhaps the easiest to understand and the one least vulnerable to criticism. She did not claim that all cultures were integrated, but only that some simpler ones were. No general laws about the integration of cultures, at any rate, were stocked in her theoretical arsenal. Except for occasional slips, she did not attempt to explain, but merely to describe, the cultures she found integrated, maintaining that a certain emotion or attitude pervaded all, or the major, activities of an entire people. It is therefore no criticism but simply evidence of a realization of the limitations of her position to point out that although she documented the hypothesis that the Zunis were moderate, she explained neither why they were moderate nor why they did the specific moderate things that they did.

Such limitations seem to be absent from the work of Malinowski. Not only did he describe individual cultures such as that of the Trobriand Islanders brilliantly, but he also offered general principles in light of which these and other cultures can be understood. As already stated, he insisted that cultures were wholes and that they must be investigated as units. He did not simply mean that a certain mood or attitude pervaded an entire culture. What, then, did he mean? No simple answer can be given, for he seems to have meant many things, all of which have been subsumed under the general rubric of a functionalistic analysis of culture and society. This analysis, though partially disclaimed by Malinowski himself, has had great influence and is therefore deserving of at least a limited review.

## Limitations of Functionalism

Functionalists (12), among whom are to be counted not only anthropologists influenced by Malinowski but also sociologists instructed by Parsons, are triply distinguished. They emphasize the interdependence of cultural units. They compare cultures to purposive agents or mechanisms. They fail to illuminate both the interdependence of cultural units and the analogy between societies and teleological entities.

Functionalists are, of course, correct if they mean that societal institutions are interdependent in the sense that changes in some institutions will produce other changes in other institutions. This position is both banal and possibly beyond disproof. Functionalists are most likely wrong if they mean that every change in every societal institution will produce at least some change in every other societal institution. There were, for example, many Indian tribes (though, to be sure, not all) who incorporated the horse into their way of life without altering many of their habits, customs, and ceremonies. The functionalists present merely prefaces to programs when they inform us that societies are integrated units and do not bother to specify the criteria for integration.

The statement that unless certain requirements for group survival are met no group can continue is a tautology. It is equally trivial that in any on-going society, certain institutions or repeated ways of behavior are either necessary or sufficient for meeting these requirements. It is not too misleading to recast these observations into teleological language and, with the functionalists, to consider societies as aiming at the solution of certain problems, and to consider institutions as functioning effectively or ineffectively with respect to such solutions.

But if teleological language sometimes can be substituted for standard scientific terminology about necessary and sufficient conditions, the converse always can be done. Even if we grant that societies are functioning organisms or, more guardedly, if we consider it of heuristic value to compare them to teleological entities, societies need no more be discussed in the language of purpose and function than Plato need be discussed in Greek. But the main problem is not the indispensability of a terminology but its employment to construct general theories. Judged by the latter criterion, the success of the functionalistic analyses of society is questionable.



It is, for example, doubtful whether societies are teleological entities in one clear and crucial respect. Ordinarily when we assert that men, animals, or machines are functioning purposively for the accomplishment of given ends or goals, we do not simply mean that some of their ways are sufficient for the achievement of the goals in question. We also mean that if they are precluded from manifesting these patterns, they will exhibit others which once again are directed toward the accomplishment of their aims. A certain plasticity of behavior is characteristic of teleological mechanisms and is not always characteristic of societies. The latter have standard ways of assuring their survival and of meeting other social requirements. And although some societies occasionally exhibit intelligent redirection, others are marked with a rigidity that expedites their extinction.

Moreover, since Radcliffe-Brown's influential work in the middle '30's, it has been a functionalistic commonplace that although many institutions are socially effective and do contribute to group survival and integration, others do not, and are, in the terminology introduced by Merton, dysfunctional. A general law about the social functioning of institutions is therefore ruled out by this admission, and we are left with the non-charismatic truth that some institutions contribute to group survival and some do not.

To criticize functionalism as a general theory is not to cast any aspersions upon specific analyses it has inspired. When, for example, we read Evans-Pritchard's account of the lineage system of the Nuer and discover that it contributes to social integration, we are enlightened (13). But our instruction consists in learning a surprising condition for social unification, not in discovering a fact which dovetails into a general theory of the functioning of societies as wholes.

This is especially true of Malinowski's work. He has informed us not only about the consequences of group actions but also about the interdependence of cultural units. But the interdependence is not a causal relationship, and it is not one that exists between institutions or ways of behavior. Malinowski demonstrated that the beliefs of primitives or members of simple societies cannot be investigated singly—that primitive beliefs form an interconnected set.

To speak of interlaced beliefs does

not mean that we commit ourselves to a geometric treatment of these beliefs. All of us, for example, have diverse opinions about our friends that impinge upon, and are impinged upon by, our beliefs about politics, love, and baseball. But it would be silly to think that these beliefs form a system with a few major postulates from which every opinion is deducible. That primitive beliefs form a system in this sense has been, at least in part, the motivation of the work of men like Opler, and for such an assumption I see no evidence.

Nor is there any basis for the thesis that once we know the beliefs of a group, we will be able to completely understand or to predict its behavior. There are no mechanical rules for the translation of belief into action, and not all primitive peoples act according to their beliefs. Malinowski himself noted many discrepancies between the beliefs or ideals of the people he investigated, and their actions. This discrepancy is not accounted for by any of the functionalistic theories of the types we have reviewed.

### Comparison with the Study of History

If a discipline is considered logically independent only when it has its own laws and theories, then anthropology is threatened with extinction as a logically independent discipline. The application of learning theory is an explicit attempt to reduce anthropological theories to those of psychology. Functionalistic analyses of culture have become incorporated into general sociological theories. Neither learning theory nor functionalism exhausts the theories employed by anthropologists, but they are the most important and the most typical. The heteronomy of anthropology is also revealed in its theoretical studies of primitive languages or social evolution.

The lack of distinct theories cannot be taken as a sign of the richness of anthropology. Nor can this lack be excused on the grounds that anthropology is a young and struggling discipline. It is old enough to have some character. On the other hand, this lack does not mean that anthropology is not a distinct discipline, with its own problems, techniques, and subject matter. It means only that anthropology may have to borrow its theories from other domains.

Anthropology has frequently been

compared, and even coupled, with psychology, sociology, and other generalizing social sciences. It may be more fruitful, with Maitland, to liken anthropology to history.

The main task of the historian is to describe significant periods and to explain crucial events, both of which aims he accomplishes with theories borrowed from all of the social sciences. For that we are in his debt. Historians who present general laws or philosophies of history are not useless. They mesmerize and provide interesting examples of fallacies even for the nonpositivistic philosophers of science. But they are on the periphery of the camp of the working historian.

It took much methodological ink in the 19th century to establish these views about history. Their counterparts about anthropology have not as yet been widely accepted (14).

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## Edward Bartow, Chemist

On Saturday afternoon of 12 April 1958, Edward Bartow died quietly at his home in Iowa City at the age of 88. He served the State University of Iowa as head of the department of chemistry and chemical engineering from 1920 to 1940 and was responsible for getting the chemistry building built in 1923. During his administration, good curricula for training chemists and chemical engineers were developed, and many graduate students were trained in the field of water chemistry. Dr. Bartow and his students published over 200 papers on all phases of water treatment. After his retirement, he taught the course in water chemistry and came to his office daily to carry on correspondence with chemists in his field of specialization—a practice which he continued until only a few days before his death.

Edward Bartow was born in Glenham, New York on 12 January 1870. He attended a preparatory academy at Fishkill, New York, and graduated from Williams College in 1892. In 1895, he

obtained his doctorate from the University of Göttingen, Germany. Upon his return to the United States, he married Alice Abbott on 3 September 1895 and started his academic career as an instructor at Williams College. He taught at the University of Kansas from 1897 to 1905, and then moved to the University of Illinois where he was professor of sanitary chemistry and director of the Illinois Water Survey, from 1905 to 1920.

Dr. Bartow served in the American Expeditionary Forces in France in 1917–18, first as a major and then as a lieutenant colonel. He directed the work of 80 officers and many privates in the difficult task of providing good drinking water and proper sanitation for the armed services. His work was recognized by the French Government with the award of the *Medaille d'Honneur*.

Dr. Bartow was a member of Phi Beta Kappa, Sigma Xi, and many scientific societies. He served as president of the Kansas Academy of Science in

1904 and, 30 years later, as president of the Iowa Academy of Science. In 1922, he was president of the American Water Works Association, of which he was a life-long member. He was a member of the American Institute of Chemical Engineers and a director of that organization from 1923 to 1925 and again from 1936 to 1939. From 1934 to 1938, he was a vice-president of the International Chemical Union as the representative of the United States. In 1936, he was elected to the presidency of the American Chemical Society, the highest office and honor his chemistry contemporaries could bestow. He attended many meetings of the International Congress of Chemistry as a representative of the United States and the American Chemical Society.

In Iowa City, Edward Bartow was a member of the Congregational Church and a loyal Rotarian. His chief hobby was stamp collecting and first-day covers. He was a member of the American Philatelic Society, the Society of Philatelic Americans, and the Trans-Mississippi Stamp Society.

Edward Bartow will be remembered as a pioneer scientist in the chemistry of water purification and the treatment of wastes to avoid pollution of streams. His friends, locally, nationally, and internationally, remember him as the tall smiling gentleman with his hand always outstretched in friendship.

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127, 389 (1958)], we will refer to the two bills before the compromise as the Administration bill (S3163) and the Hill-Elliott bill (S3187).

### Analysis of Earlier Bills

The Administration bill has the following major provisions: (i) authorization for approximately 40,000 scholarships over a 4-year period to be awarded on the basis of need by the individual states after competitive examination of their college-age applicants; (ii) authorization for funds, to be matched by the states, for the establishment of new or larger student guidance and counseling agencies; (iii) grants to individual universities for the expansion of fellowship and graduate education programs as recommended by the university and approved by the Commissioner of Education; (iv) grants to states of \$15 million a year for 4 years for the purpose of aiding the establishment of programs

## News of Science

### Science Education Legislation

Various opinions have been voiced on the prospects of passage of a Federal aid to education bill before adjournment of Congress, which is expected to occur between 15 August and 1 September. At this date, 23 July, informed opinion seems to hold that there are grounds for optimism that legislation on this matter will be passed this year.

The House bill, which may or may not gain passage, represents a compromise between two earlier bills introduced in both chambers. A brief analysis of these earlier bills will be of value in comparing them with the new bill which is threatened by adjournment.

Making use of a scheme of identification employed in an earlier issue [Science

for supervising instruction in science and mathematics, for improving science and mathematical curricula, and for related work; (v) grants or contracts with institutes of higher education to support short-term and regular-session institutes for advanced training of teachers or prospective teachers of foreign languages, and funds for supporting stipends to these teachers; and (vi) the authorization of funds up to \$50,000 a year for 4 years to assist any state to improve the adequacy and reliability of its educational statistics. The individual state would be required to match this fund.

The Hill-Elliott bill, while similar in purpose—bettering the quality and quantity of the country's educated young people, particularly in the fields of mathematics and science—offers different means for accomplishing this end. Its major provisions are: (i) 240,000 scholarships over a 6-year period, awarded according to merit rather than need by the individual states; (ii) permanent authorization for \$15 million a year to be matched by the states in the third and succeeding years for the purpose of improving counseling and guidance work; (iii) grants for the awarding, on a national basis, of 1000 fellowships the first year and 1500 additional ones in each of the next 5 years; and (iv) allocation among the states of \$10 million a year, on a matching basis, for paying or supplementing the salaries of science, mathematics, and modern foreign language consultants.

The Hill-Elliott bill also has the following provisions, which are not found in the Administration bill: (i) scholarships for the year 1958-59 for students now in college; (ii) a student loan fund of \$40 million a year; (iii) stipends for teachers engaging in summer and extension work, particularly in the sciences and mathematics; and (iv) provisions for honorary citations for superior high-school work, for a science information service within the National Science Foundation, for aid for vocational training, and, in a marked departure from the Administration pattern of means, a provision for funds for research in the matter of the development and use of television, radio, motion pictures, and related media as they may have value in education.

#### Comparison

Out of the welter of debate in the House Education and Labor Committee has come a bill which fully incorporates some of the provisions of the earlier bills, rejects others, and modifies to a greater or lesser degree those remaining.

The number of scholarships granted by the compromise bill runs between 76,000 and 88,000 over a period of 4 years. This is about twice the number

asked for by the Administration bill and about one-third the number called for in the original Hill-Elliott bill. The scholarships would be administered by the individual states, as is required by Federal law, and financial support would be on the basis of \$500 an academic year for all successful applicants, with another grant, up to \$500 a year, to be available to students with a demonstrable need for further aid. This arrangement represents a compromise of the need or merit problem as it arose in the earlier bills.

Compromise can also be seen in the provisions for counseling and guidance. A 4-year grant, rather than a permanent grant, as in the Hill-Elliott bill, would be given to the states, to be matched by them, for the purpose of establishing and maintaining programs of testing, guidance, and counseling. An additional fund would be granted to arrange, through contracts with institutions of higher learning, for the establishment and operation of summer- or regular-session institutes that would offer courses in counseling and guidance of students at secondary school level. Stipends would be paid to eligible persons who attend such institutes.

In the matter of graduate study, the provisions of the Hill-Elliott bill have been adopted with minor changes, notably reduction in the period of availability of the grants.

The new bill modifies those provisions of the Hill-Elliott bill that grant aid to states for the purpose, among others, of improving those parts of the physical plant that are used for instruction in the sciences, mathematics, and modern foreign languages. Instead of the 6-year period of enactment, a 4-year period is used, but the funds authorized are increased from \$40 million a year to \$60 million. The result in both cases is a total expenditure of \$240 million.

In addition to support for language study mentioned above, the new bill incorporates the major relevant provision of the Administration bill: supported supplemental study for teachers of language.

In its other provisions the bill now before the House retains elements of the Hill-Elliott bill which were not found in any equivalent form in the Administration bill. Most notably, these are the sections calling for the establishment of a student loan fund of \$40 million for the current year, jumping to \$60 million in the succeeding 3 years (the original called for a steady \$40 million a year for 6 years), and the section calling for research and experimentation in more effective utilization of television, radio, motion pictures, and related media for educational purposes. Under this pro-

vision, an \$8 million fund would enable the Commissioner of Education, through grants or contracts, to (i) make studies and surveys to determine the need for increased or improved utilization of television, radio, motion pictures, and related media of communication by state or educational agencies and institutions of higher education in providing education; (ii) conduct research, demonstrations, and experiments in the use of such media for such purposes; (iii) conduct research, demonstrations, and experiments in the development and use of new media of communication; (iv) evaluate and publish reports concerning the effectiveness of such media for such purposes; and (v) prepare and publish abstracts and catalogs of audiovisual material available, to the extent such abstracts or catalogs are not otherwise readily available. The U.S. Commissioner of Education would provide, upon request, advice, counsel, and technical assistance to state and local educational agencies and institutions of higher education undertaking to utilize such media of communication in providing education.

#### Civilian Space Agency

A governmental agency to coordinate nonmilitary problems of space exploration is expected to come into existence in the near future. The agency, which will be under civilian control, will be called the National Aeronautics and Space Administration and will have jurisdiction over all aeronautical and space activities except for those which President Eisenhower determines to be primarily associated with national defense.

The bill calling for the establishment of the agency (HR 12575) has been passed by both the House and the Senate and has been signed by the President. Among its provisions, the bill:

- 1) Declared it to be U.S. policy that activities in space should be devoted to peaceful purposes.
- 2) Established the National Aeronautics and Space Council composed of the President, the secretaries of State and Defense, the administrator of the National Aeronautics and Space Administration, the chairman of the Atomic Energy Commission, and four other appointees—three nongovernment.
- 3) Directed the President, with advice of the Council, to develop a comprehensive program of aeronautical and space activities, allocate responsibility for major projects, provide for effective cooperation, and resolve differences among departments and agencies.
- 4) Directed the NASA to coordinate and conduct aeronautical and space ac-

tivities, arrange for participation by the scientific community, disseminate information, and make semiannual reports on its activities.

5) Authorized the administrator to acquire and develop research facilities, aeronautical and space vehicles, and related property and accommodations; hire 260 specially qualified scientific and engineering personnel at pay grades higher than provided in the Classification Act of 1949 and to pay others entering Federal service for the first time at rates two grades higher than usual starting salaries; make monetary awards for significantly valuable scientific or technical contributions.

6) Declared that any relevant invention made in the performance of contracted work under the NASA would be the exclusive property of the U.S. Government and authorized the administrator to apply for or waive patent rights.

### Physics Course

The Educational Testing Service, Princeton, N.J., reports that a new physics course will undergo its first large-scale evaluation in 300 of the nation's schools next fall. Frederick L. Ferris, Jr., associate director of test development at ETS, is in charge of the evaluation aspects of the study, which may involve testing as many as 10,000 high school students several times during the academic year.

The new program was developed by the Physical Science Study Committee, a group of scientists, teachers, and education specialists who have been working for 2 years under the leadership of Jerrold R. Zacharias at Massachusetts Institute of Technology. The committee staff, supported by grants from several large foundations, has developed a new text; a laboratory manual, including many ingenious experiments; and a variety of visual aids. More than 50 new motion pictures for this project are now in production.

Summer institutes are being sponsored by the National Science Foundation at five colleges for the 300 teachers who will use the new materials next fall. Teachers at these institutes will take special tests. These tests will provide a basis for study of the relationship between the achievement of teachers and the subsequent achievement of their pupils.

### Associated Midwest Universities

Twenty-six leading educational and research institutions have formed an inter-university corporation to be known as Associated Midwest Universities, a successor to the organization formerly

known as Participating Institutions of Argonne National Laboratory. James H. Jensen, provost, Iowa State College, is the first president of the new organization, which has headquarters at the Argonne National Laboratory's main site near Lemont, Ill.

The articles of incorporation list three main purposes for organizing the new corporation:

1) To promote, encourage, and conduct research and education in all branches of science, including but not limited to nuclear science in relation to all other fields of science.

2) To establish means for facilitating the use of the Argonne National Laboratory and other laboratories by duly qualified personnel and students from the several cooperating institutions and other research and educational institutions.

3) To establish, maintain, and operate laboratories and other facilities as necessary for research and education.

This is the third such university association to be organized within the framework of the Atomic Energy Commission. The first two are Associated Universities, Inc., which is the AEC's contractor for operations of the Brookhaven National Laboratory, Upton, N.Y., and the Oak Ridge Institute of Nuclear Studies, which directs educational and other activities associated with the Oak Ridge (Tenn.) National Laboratory for the AEC. The administrative framework of Associated Midwest Universities is expected to be somewhat similar to that of ORINS.

### Toward Controlled Fusion Reactions

Recent Congressional hearings have brought out new information on the progress of United States attempts to harness the hydrogen bomb reaction for industrial power.

Two main conditions must be attained before it is possible to utilize the power released in a fusion reaction. First, heavy hydrogen must be brought to a temperature of at least 100 million degrees centigrade. Second, the atomic nuclei in this hot gas must be held together for an appreciable time. Scientists working at the University of California Radiation Laboratory, an Atomic Energy Commission facility, have concerned themselves with the first of these two conditions and are "well along the road" to the temperature objective, according to testimony released by a House Appropriations subcommittee.

Temperatures of 10 million degrees, 90 million degrees short of the required temperature level for a controlled hydrogen fusion reaction, have been generated by the University of California

scientists. While the achievement of the objective temperature itself will not lead to the immediate availability of the power of fusion reactions, it is a prime objective and its attainment will be a major advance toward the solution of problems surrounding the controlled release of fusion reaction power.

### TV Program on the Senses

*Gateways to the Mind*, a discussion of human senses, will be the next Bell System Science Series TV program. It will be seen on the NBC network on the evening of 23 October. This 1-hour color film, one of a continuing series, presents the story of man's knowledge about his senses and their function as the channels through which all awareness of the external world is passed to the brain.

Producer-director Owen Crump uses a movie sound stage as the setting for this story of the senses, with Frank C. Baxter explaining the story to a production crew about to start on a picture. The scientific material that will be presented during the course of the program includes animated sequences, documentary films, and sequences of experiments dealing with optical illusion.

George Wald of Harvard University served as principal adviser for the production, with Frederick Crescitelli, professor of zoology at the University of California, Los Angeles, acting as consultant. The scientific material in the program was prepared under the general supervision of a 10-member advisory board. Starting with Aristotle's discussion of the five senses, the program shows how scientific research in the past has increased the list of recognized senses to include balance, pressure, pain, tension, and so forth, and how current research at Princeton, McGill, and other institutions is expanding man's knowledge of sight and of the brain's role in sensory perception.

After the initial telecast, the Bell Telephone Companies will make the program available to schools and other interested groups in 16-mm color films.

### Summer Research in Geology

A group of 50 students of geology composed of faculty members, graduate students, and undergraduates has departed from Princeton University to take up summer research projects in Canada, the Caribbean, Western Europe, and other areas.

One project, on which the chairman of the department of geology has spent the past 12 summers, involves the study of the formation and development of mountains and the relationships of



earthquakes and volcanic eruptions to the mountain-making process. The group doing this work will be located along the north coast of South America and in the Antilles Islands in the West Indies.

Mapping and survey work will be done by two teams of men, one in the interior areas of the Dominican Republic, and the other in Wyoming and Montana.

The search for fossil plants and vertebrates will be conducted by teams operating in western United States.

Other crews will investigate Stone Age cultures in southwest France and Ice Age deposits in northern New York State. In this last investigation, radiocarbon dating methods will be employed.

### Traveling Astronomers

The Visiting Professors in Astronomy program, supported by the National Science Foundation, is being prepared for the academic year 1958-59. The program, which is administered by the American Astronomical Society, aims to strengthen and stimulate college programs in astronomy and in other physical sciences, to give astronomers and other scientists opportunity for contact with creative astronomers from other universities and observatories, and to motivate good college students to consider careers in astronomy or one of the other physical sciences.

The visiting professors will give general college addresses, lecture to astronomy classes, or participate in seminars. They will be glad to advise students on opportunities for advanced study and employment in astronomy and to discuss teaching problems and curriculum with members of the faculty. In short, the lecturers will cooperate with the colleges in all ways that they can to further the aims of the program. A normal visit by a professor will last for 2 or 3 days. The program asks that each participating institution contribute \$50 to cover the costs of maintaining the visiting professor. All other expenses will be paid by the National Science Foundation.

There will be approximately eight professors available between 1 October 1958 and 1 June 1959. Their names will be released shortly.

For further information, write William Liller, The Observatory, University of Michigan, Ann Arbor, Michigan.

### World of the Mind

A new radio series, *The World of the Mind*, written by more than 50 outstanding American scientists and teachers, was announced by Carl Haverlin, president of Broadcast Music, Inc., which has prepared the programs in cooperation

with the American Association for the Advancement of Science and the American Council of Learned Societies. The programs are being made available, without charge, by BMI to all radio and television stations and to public libraries and local boards of education to be used in connection with broadcasting.

The series encompasses a wide range of topics in the sciences and the humanities. Each of the papers, intended to be presented by local broadcasters, has been written by an American scholar or scientist and concerns either the work of a learned organization of which he is a member or the particular scientific field in which he is an expert.

In commenting on the programs, Wallace R. Brode, president of the AAAS, Science Adviser in the Department of State, and a contributor to the series, said: "As science becomes a more important subject in our area of knowledge, and as man begins to know and accept the basic facts of science, he is becoming better prepared to know and understand the more complex aspects of science. If we can, in these presentations, border on the area where the subject matter presents an intellectual challenge to the listener and stimulates new ideas and thoughts, and increases the listeners' knowledge as well as appreciation of science, we will have been successful and will feel that our efforts were well worth while. Science exists, whether we can explain it or not, but man's full use and advantage of science can come only by increased knowledge and understanding on his part."

Some of the programs prepared in cooperation with the AAAS follow:

*The Sun*, by Walter Orr Roberts, director, High Altitude Observatory, and head, department of astrophysics, University of Colorado.

*How the Village-Farming Community Came into Being*, by Robert J. Braidwood, professor, department of anthropology, University of Chicago, Oriental Institute professor of Old World prehistory.

*Linguistics*, by Norman A. McQuown, associate professor of anthropology and of linguistics, University of Chicago.

*Atomic Radiations and Hereditary Effects*, by Hermann J. Muller, professor of zoology, Indiana University.

*Experiments on Anxiety*, by Charles W. Eriksen, associate professor, department of psychology, University of Illinois.

*Twentieth Century Population Problems*, by Conrad Taeuber, assistant director, Bureau of the Census, United States Department of Commerce.

*The Political Economy of National Security*, by Benjamin H. Williams, member, staff and faculty, Industrial College of the Armed Forces.

### Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills recently introduced follows:

HR 13091. Authorize expenditure of funds through grants for support of scientific research. Harris (D-Ark.). House Interstate and Foreign Commerce.

HR 13109. Strengthen national defense and encourage and assist in expansion and improvement of educational programs to meet critical national needs. Dellay (D-N.J.). House Education and Labor.

HR 13069. Stabilize production of copper, lead, zinc, acid-grade fluorspar, and tungsten from domestic mines. Aspinall (D-Colo.). House Interior and Insular Affairs.

S 3695. Authorize an increased program of research on forestry and forest products. Humphrey (D-Minn.). Senate Agriculture and Forestry.

HR 13074. Establish a national wilderness preservation system for permanent good of the whole people. Metcalf (D-Mont.). House Interior and Insular Affairs.

HR 13138. Amend act of 10 March 1934 to provide for more effective integration of a fish and wildlife conservation program with federal water-resource developments. Boykin (D-Ala.). House Merchant Marine and Fisheries.

HR 13191. Require Commissioner of Education to encourage, foster, and assist in establishment of clubs for boys and girls especially interested in science. Wright (D-Tex.). House Education and Labor.

HR 12844. Create an independent Federal Aviation Agency to provide for safe and efficient use of airspace by both civil and military operations, and to provide for the regulation and promotion of civil aviation in such manner as to best foster its development and safety. Church (R-Ill.). House Interstate and Foreign Commerce.

HR 12023. Establish a program to enable students in fields of science and mathematics to attend high schools and institutions of higher education; improve teaching of science and mathematics in schools of the nation; make grants to permit construction of minimum facilities for teaching of science in schools of the nation. Fogarty (D-R.I.). House Education and Labor.

### News Briefs

Of the many countries in the British Commonwealth, Australia has known the most rapid progress in research, according to L. J. F. Brimble, editor of *Nature*, who is currently in that country on a



visit sponsored by the Nuffield Foundation and the Commonwealth Scientific and Industrial Research Organization. In certain fields, notably agriculture and radiophysics (which is regarded as a discrete discipline in Australia, with radioastronomy and radio navigation and propagation among its subdivisions), Australian research leads the world, Brimble added.

\* \* \*

The Atomic Energy Commission's Health and Safety Laboratory has brought out a four-volume collection of available information on radioactive fallout. The set, which contains data on fallout through 1957, is intended primarily as a reference work for specialists in the field.

The first two volumes, A and B, contain a compilation of fallout data, while the last two are comprised of bibliographies and complete scientific papers on the subject.

The work is titled: *Environmental Contamination from Weapons Tests: A compilation of data concerning transport, deposition, distribution and biological uptake of world-wide radioactive fallout.*

\* \* \*

The Atomic Energy Commission will add another classified documents depository to the six now in existence throughout the country. The new facility, designed to serve the western states, has an initial collection of 7000 reports dealing with various aspects of nuclear-energy research. It will be located at the Stanford Research Institute in Menlo Park, California, and will be open for use by scientists and engineers of firms holding AEC access permits. The institute has maintained a depository of unclassified nuclear energy reports since 1954.

\* \* \*

A bill to prohibit interstate shipment of dogs or cats for medical or other scientific experimentation has been introduced in Congress by Rep. Usher L. Burdick (R-N. Dak.). It would provide a maximum penalty of a year's imprisonment and a \$1000 fine. Enactment of the Burdick Bill would hamper the operations of many of America's medical research and teaching institutions.

\* \* \*

Eight areas of the United States have been provided with service offices of the Atomic Energy Commission for the purpose of meeting any emergency involving the accidental release of radioactivity. These offices, staffed with scientists, engineers, and physicians trained in handling radioactive materials, will serve to protect the public from any accidents, such as the involvement of a truck carrying "hot" substances in a traffic accident, which might release potentially dangerous amounts of radioactivity. Locations of the eight offices are as follows:

New York, N.Y.; Oak Ridge, Tenn.; Aiken, S.C.; Albuquerque, N.M.; Chicago, Ill.; Idaho Falls, Idaho; Oakland, Calif.; and Richland, Wash.

\* \* \*

The National Bureau of Standards has reported that precise international comparisons have established that the optical pyrometer temperature scales of Canada, the United Kingdom, Germany, and the United States are in satisfactory agreement. Thus, within these countries, all measurements of high temperatures now have a common basis, and the results obtained in one laboratory should be comparable with those obtained in another.

### Grants, Fellowships, and Awards

**Graduate study abroad.** The Institute of International Education, which administers awards for the U.S. Government under the Fulbright Act and the Inter-American Cultural Convention and for various foreign governments and universities, is receiving applications for scholarships for graduate study abroad. United States citizenship, a bachelor's degree or its equivalent, and language ability to carry on the proposed study are required. The deadline for applications is 1 November. Detailed information may be obtained from the Institute of International Education, 1 E. 67 St., New York, N.Y.

**Social science.** During the academic year 1958-59 the Social Science Research Council will accept applications from permanent residents of the United States and Canada for the following types of fellowships and grants for training or research in social science: (i) Predoctoral and postdoctoral research training fellowships to provide more advanced research training than that afforded by the usual Ph.D. program. (ii) Fellowships in political theory and legal philosophy, open to Ph.D. candidates who have completed all requirements except the dissertation and to persons who have received the Ph.D. or a law degree within the past 3 years. (iii) Grants-in-aid of research and faculty research grants in amounts up to \$6000 to defray direct costs or to provide free time for individual research, or both; available only to scholars who are no longer candidates for degrees and whose capacity for effective research has been demonstrated by previous work. In 1958-59, for the first time, these grants will be awarded both in January and in April, with closing dates for applications 1 November 1958 and 1 February 1959, respectively. (iv) Special grants for social science research in the American governmental processes, the Near and Middle East, and in Slavic and East European studies. (v) International conference

travel grants equivalent to tourist-class fare for social scientists attending certain international meetings to be designated by the council.

Closing dates for applications or nominations differ for the several programs, the earliest being 15 October. Prospective candidates are urged to write to the Social Science Research Council, 230 Park Avenue, New York 17, N.Y., as early as possible to be assured of receiving the detailed announcement which will be issued toward the end of summer. Requests for application forms should indicate age, highest academic degree held, present position, or activity, and the purpose for which a fellowship or grant is desired.

**Clinical studies.** The Lipotropic Research Foundation of New York will receive applications for grants-in-aid for 1959 until 1 October 1958. Special attention is given to clinical studies. A request for application forms, which should include a short statement describing professional affiliations and experience, may be addressed to the administrative secretary, Dr. L. Lipton, 26 Vark Street, Yonkers 1, N.Y.

**Medical research.** The Life Insurance Medical Research Fund is now receiving applications for two types of awards, to be available 1 July 1959, as follows: (i) Postdoctoral research fellowships. Candidates may apply for support in any field of the medical sciences. Preference is given to those who wish to work on fundamental problems, especially those related to cardiovascular function or disease. Minimum stipend is \$3800, with allowances for dependents and necessary travel. Applications will be received until 15 October. (ii) Grants to institutions. Support is available for physiological, biochemical, and other basic work broadly related to cardiovascular problems as well as for clinical research in this field. The deadline for applications is 1 November 1958.

Further information and application forms may be obtained from the Scientific Director, Life Insurance Medical Research Fund, 345 E. 46 St., New York, N.Y.

**Medicine.** Nominations are invited for Lederle Medical Faculty Awards of the Lederle Laboratories Division of American Cyanamid Company. The awards are intended to assist able men and women who are working and contemplating further careers in the preclinical departments of medical schools.

The program will provide financial aid for a period not exceeding 3 years to support young individuals who have demonstrated capacities both as teachers and investigators in departments of anatomy, biochemistry, microbiology, pathology, pharmacology, and physiology, in order to help accelerate their devel-

opment and to encourage them to remain in these disciplines. The plan is intended to assist departments to offer opportunities for development of promising individuals.

The awards are designed for persons who have progressed beyond the state of development which is now encompassed by postdoctorate fellowships. Recipients must hold "faculty rank," such as instructor or assistant professor.

Nominations should be submitted to the Lederle Medical Faculty Awards Committee through the office of the dean of the medical school by 31 October. Complete information may be obtained from Lederle Medical Faculty Awards, Office of the Secretary, Pearl River, N.Y.

### Scientists in the News

LARKIN H. FARINHOLT, professor of chemistry and director of the Chemical Laboratories at Columbia University, has been appointed deputy science adviser to the Department of State.

JEROME C. HUNSAKER, emeritus professor, Massachusetts Institute of Technology, was presented the Navy Distinguished Public Service Award by G. Norton, Assistant Secretary of the Navy for Air. This award, the highest conferred on civilians by the Department of the Navy, recognizes Hunsaker's singularly outstanding contributions in the fields of scientific research and development. His penetrating insight into technical and organizational problems have proven invaluable to the Navy.

EVA V. ARMSTRONG, former curator of the Edgar Fahs Smith Memorial Library, University of Pennsylvania, has been selected for the third annual Dexter Chemical Corporation Award in the history of chemistry. The award will be presented 9 September at the American Chemical Society's annual convention in Chicago. The \$500 prize was established by Dexter to recognize "noteworthy contributions to the advancement of the history of chemistry."

JOHN J. BIESELE, now at the Sloan-Kettering Institute for Cancer Research in New York, will join the University of Texas faculty in September as professor of zoology.

DAVID GROB, associate professor of medicine at Johns Hopkins University School of Medicine, has been appointed professor of medicine at the State University of New York Downstate Medical Center and full-time director of medical services at Maimonides Hospital of Brooklyn.

MERVIN J. KELLY, president of Bell Telephone Laboratories, will be the 1959 recipient of the John Fritz Medal, it has been announced by the John Fritz Medal Board of Award.

Cited for "his achievements in electronics, leadership of a great industrial research laboratory, and contributions to the defense of the country through science and technology," Kelly will receive the award at ceremonies to be scheduled by the American Institute of Electrical Engineers, of which he is a fellow.

DONALD H. FLEMING, chairman of the department of history at Brown University for the past year and one of the nation's outstanding young historians, has been appointed to the newly created professorship of the history of science at Yale University. Yale thus becomes one of the few universities in this country to have a chair in the history of science.

JOSEPH M. QUASHNOCK, chief of the department of aviation medicine, School of Aviation Medicine, Randolph Air Force Base, Tex., has been named commander of the Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

The appointment of LEROY A. BROTHERS as dean of the College of Engineering of Drexel Institute of Technology has been announced. Brothers succeeds HARRY L. BOWMAN, who will continue as dean of the faculty.

MAX S. PETERS has been appointed head of the division of chemical engineering in the University of Illinois's department of chemistry and chemical engineering, effective 1 September. He joined Illinois in 1951 as assistant professor of chemical engineering and was promoted to professor in 1957. Peters succeeds H. G. DRICKAMER, who will continue as professor of chemistry and chemical engineering.

JOHN B. STORER has joined the research staff of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me. He was previously alternate leader of the Biomedical Research Group of the Los Alamos Scientific Laboratory.

The Atomic Energy Commission's Division of International Affairs, upon request of the Polish government to the U.S. Department of State, has selected WILLIAM G. POLLARD, executive director of the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee, to make a special trip to Poland this month.

Pollard will be accompanied by RICHARD H. CHAMBERLAIN of the University of Pennsylvania. The two

will hold discussions with Polish scientists and government representatives on the unclassified topics of radioisotopes in science and industry, fundamental chemistry, design of radiochemical laboratories, and neutron physics.

KENNETH D. JACOB of the U.S. Department of Agriculture has been awarded the Harvey W. Wiler award of the Association of Official Agricultural Chemists.

WILLIAM B. ATKINSON, associate professor of anatomy at the University of Cincinnati School of Medicine, has been appointed chairman of the department of anatomy at the University of Louisville School of Medicine, to succeed S. I. KORNHAUSER, who has been chairman since 1922.

RICHARD E. WATSON of the Leeds and Northrup Co. and CHARLES W. MALICH of the Naval Research Laboratory have accepted positions as professor and associate professor of physics, respectively, at Southern Illinois University, Carbondale, Ill.

SERGEI A. SCHELKUNOFF who is assistant director of mathematical research at Bell Telephone Laboratories, Inc., Murray Hill, N.J., has been appointed adjunct professor of electrical engineering at the School of Engineering of Columbia University.

EDWARD F. KNIPLING, director of Entomology Research Division of the U.S. Department of Agriculture, has been presented with an alumni Award of Merit by the Iowa State College Alumni Association.

JOSEPH C. PATRICK, whose discoveries led to the production of the first synthetic rubber in the United States, has been named recipient of an Elliott Cresson medal, which is awarded annually by the Franklin Institute to one or more persons for discovery or original research adding to the sum of human knowledge.

OLIVER GRUMMITT has been appointed chairman of the department of chemistry, Western Reserve University. He succeeds FRANK HOVORKA, who will continue his teaching and research in physical chemistry.

Announcement has been made by the National Academy of Sciences-National Research Council of the appointment of H. BURR STEINBACH as chairman of the Academy-Research Council's Division of Biology and Agriculture. Steinbach is head of the department of zoology at the University of Chicago.

## Book Reviews

**Of Stars and Men.** The human response to an expanding universe. Harlow Shapley. Beacon Press, Boston, 1958. vi + 157 pp. \$3.50.

In this book, Harlow Shapley seeks to overthrow the anthropocentric view of the universe. So, far from believing the sun's system of planets, the earth, and its life and intelligent creatures to be unique, he would make them of common occurrence. If many stars besides the sun have planetary systems, and if there is no direct observational evidence for the existence of these systems, it is necessary to argue from theories of the origin of the solar system and from probabilities. Fifteen theories are listed on pages 66 and 67; six are rejected, two are classified as doubtful, and seven may pass muster, though Shapley admits that he is not entirely satisfied with any of them.

The number of stars in the universe is estimated at  $10^{20}$ ; in order to find the number with planetary systems, Shapley multiplies together four probabilities, each equal to  $10^{-3}$ , thus arriving at the conclusion that one star in  $10^{12}$  has a planetary system like the sun's. Thus, there are  $10^8$  such systems in the universe. It is most unfortunate that, in the compass of a small book, Shapley can devote only two or three pages (pages 72 to 74) to this important argument. The curious reader would have liked a detailed presentation of the evidence for the value of  $10^{-3}$  assigned to each probability; if  $10^{-5}$  is used instead, one predicts that only a single star out of the  $10^{20}$  has planets.

The title of Chapter 6, "Rainbows and cosmic chemistry," seems to imply that the astronomer has found spectroscopic evidence of chemical processes—that is, of molecular combinations and interactions—taking place in the universe. This is difficult to reconcile with the observations, which indicate that matter in the universe occurs overwhelmingly in the gaseous state and as separate atoms. Only the simplest types of molecules are detected spectroscopically. Indeed, it is a curious fact that chemical compounds possessing any degree of complexity are detected by direct observation only on the earth, in meteorites,

and in the atmospheres of the sun's planets.

In chapter 9, Shapley regards the artificial production of amino acids in the laboratory as evidence that, apart from some minor details, the nature and origin of life are understood. The prime difficulty—namely, that the artificial synthesis of amino acids, proteins, and other elaborate chemical compounds found in living matter produces materials that are as "dead" as the hydrogen, nitrogen, carbon, and oxygen of which they were compounded—is not discussed. In his final chapter, "What should be the human response?" Shapley pleads for humility in man as he contemplates the astronomical universe, and he has some encouraging remarks to make regarding the probability that man will continue to survive on this planet.

G. C. McVITTIE

*University of Illinois Observatory*

**Some Applications of Behavioural Research.** Rensis Likert and Samuel P. Hayes, Jr., Eds. UNESCO, Paris, 1957. 333 pp. \$3.25.

This little book is a product of the Foundation for Research on Human Behavior, an organization that over the past five years has pioneered in the interpretation of research in the social sciences to representatives of industry and government and in the solicitation from industry of long-term support for research by university-based social scientists working on problems where "basic" and "applied" interests converge. One of the activities of the foundation has been a series of brief seminars in which behavioral scientists discuss a particular research topic with persons from business and government thought to have potential interest in its application. Typically, a panel of several "experts" on the topic covers much the same ground with several seminar groups, and a report on the material presented and discussed is subsequently prepared for distribution to the participants. Most of these reports have been admirable examples of responsible popularization; while copies of them could be obtained from the founda-

tion, their circulation has not been as wide as they deserve. The present volume, mainly composed of these seminar reports, thus performs a useful service in making them more widely available.

It is in this connection that the volume is appropriately evaluated. Its production under UNESCO auspices might, on the other hand, give rise to different expectations that the book would disappoint. Not only is the research reviewed an entirely American product but the interests of behavioral scientists associated with the Institute of Social Research at the University of Michigan, with which the foundation has an informal symbiotic relationship, are preponderantly (though by no means exclusively) represented. And the areas of application emphasized fall heavily within the sphere of American "big business." The reader in this country or abroad should realize that the reports gathered here are not intended as a representative sampling either of American "behavioral science" or of its actual or potential fields of application, but that he would nevertheless find a number of able, nontechnical, and practically oriented summaries of recent research, together with references to selected primary sources.

The topics treated fall into four program areas in which the foundation has been interested: leadership, management, and organization; public communications; economic behavior; and cross cultural operations. The chapter headings indicate the subject matter: "Administrative leadership and organizational effectiveness," "The training of leaders for effective human relations," "Human factors in effective research administration," "Training foreign nationals in the United States," "Group influence in marketing and public relations," and "Psychological surveys in business forecasting." Initial and final chapters deal in more general terms with problems of applying behavioral research effectively.

M. BREWSTER SMITH

*Department of Psychology,  
New York University*

**New Bottles for New Wine.** Julian Huxley. Harper, New York, 1958. 318 pp. Illus. + plates. \$4.50.

This latest collection of Huxley's entertaining essays on scientific subjects is treated with his usual broad understanding of the relation of science to man. Huxley is again concerned with evolution in its broadest sense. His primary theme is where man is going and why. In the best tradition of British popularization, the book is filled with interesting



examples from its author's vast store of biological and literary knowledge.

Huxley gives as the most remarkable development of the present century "man's unveiling of the face and figure of the reality of which he forms a part, the first picture of human destiny in its true outlines." He feels that "the most important, if not the most urgent task of our times, is the development of a new set of integrated, directive and transmissive mechanisms for human societies and for their continuity down the generations." He criticizes the Marxian system and the behaviorists on the one hand for trying to deny the validity of the mental and spiritual elements in the universe and, on the other, the mystics, the idealists, and the theologians, some of whom try to deny the importance of the material elements. Man must, he says, learn how to think in terms of organization and pattern, and in terms of trend and process.

Most of the essays have appeared in print over the past seven years as lectures and general articles, although some are here considerably expanded. There are minor repetitions in the book, and somewhat closer editing would have reduced the impression that the author produces a new volume whenever the storage bin of lectures and articles gets filled to appropriate depth. Thus, the essay entitled "Knowledge, morality, and destiny" starts out, "Our Western world in this year 1951 is psychologically in a bad way."

But it is all prime Huxley, which is very good indeed, quoting Walt Whitman or Darwin with equal facility, free-ranging, sparkling, imaginative, comprehensive, factual, speculative, interesting, and stimulating. It is good to have these essays under one cover.

GEORGE R. HARRISON

School of Science,  
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**Exotica.** Pictorial cyclopedia of indoor plants. Alfred Byrd Graf. Roehrs Company, Rutherford, N.J. 1958. 4000 illus., 644 pp. \$17.50.

The last two decades have seen a revolution in the way tropical and subtropical plants have been introduced into cultivation in the temperate zone. Glass-sided homes, fluorescent lighting, plastic glass, and air-control equipment have made it possible for millions of Americans to live with tropical plants throughout the year if they so desire. The five-day week has brought to people with lively minds the need for more absorbing hobbies. The rise of mass-production ornamental horticulture has been one of the results. The gardens and the jungles of the tropics and subtropics

are being combed for likely plant material.

A little-known species or hybrid of *Peperomia* or *Syngonium* may now be in mass production within two years from the time it was first collected in the back corners of Brazil. There are already over 150 species and varieties of *Philodendron* in cultivation in this country; hybridization programs are well under way which will multiply the number of named varieties in another decade. The total national business in African violets alone, I am reliably informed, now grosses more than all the nursery business in temperate and tropical fruits, apple trees, peach trees, current bushes, avocado trees, and so on. The poorly known genus *Schefflera* was of so little commercial importance when the last edition of Bailey's *Manual of Cultivated Plants* was being planned that it did not even qualify for admission. Today the production of large tubed specimens for glass-sided office buildings has become big business. One can scarcely stroll through the business district of a city in the eastern United States without seeing a *Schefflera* (or near-*Schefflera*, for the precise limits of the genus have not yet been worked out) in a bank or cafeteria.

This trend is the raw material of social history; it is changing various kinds of attitudes towards plants and towards their cultivation and study, in all classes of society in the United States. Eventually our technical, botanical and horticultural works will catch up with this flood of new introductions and reduce to some kind of order their identification, history, and significance. Until then, the amateur, the social historian, the horticulturist, even many taxonomic botanists will get their most immediate help out of Graf's remarkable book. Most systematists who give their concentrated attention to the sections of the book dealing with their own specialties will wince at the inaccuracies they find; many of them, however, will learn to use the book as an effective first approach to the other fellow's specialties. That anyone should have been able to survey this rapidly growing flood of exotic plants is a marvel; that a busy executive like Graf should have produced this 644-page compendium approaches the miraculous. He is the manager and a director of the Roehrs Company of Rutherford, New Jersey, one of the principal dealers in and growers of this kind of plant material.

The chief feature of the book is some 450 pages of clear photographs illustrating close to 4000 of the species and varieties of tropical and subtropical ornamental plants. There are indices to common names and scientific names, a glossary of botanical terms, short semi-technical descriptions, a section on pest

control, and a discussion of the climates from which these plants came, complete with a climatic map of the world. There are short introductory pages on the care of house plants (don't overfeed and don't overwater!) which are of more practical help to the average intelligent person than most books on the subject.

One of the most valuable features of the book is a 40-page summary of the kinds of places where these plants have been collected. There are on each of these pages three or four of Graf's excellent photographs showing the deserts and jungles, the temples, gardens, and nurseries from which ornamental plants have been gathered. Graf's comments supply an effective summary of the conditions under which ornamental plants are being grown in various parts of the tropics, as well as considerable insight into why they are being grown and the various ways in which they are being used. Since he has traveled and collected throughout the tropics with an inquiring mind and a good camera, he has unwittingly produced our first compendium of tropical man's attitudes towards plants.

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**L'Enfant Néanderthalien du Pech de l'Azé.** Etienne Patte. Masson, Paris, 1957. 234 pp. + viii plates. Illus. Paper, F. 2500.

The infant which is the main subject of this impressive study is represented by only an incomplete skull and lower jaw. Not indicated, but also included (pages 197-226), is the description of another Neanderthal infant (from Chateaufort-sur-Charente) represented by only a fragment of mandible. Both specimens were between 2 and 3 years of age; they were discovered nearly a half century ago by Peyrony and Chauvet, respectively. The second specimen is so little known that it was not included in the *Catalogue des Hommes Fossiles* (Vallois and Movius *et al.*, 1953).

Reading soon reveals that this report is padded with somewhat irrelevant and outmoded data. For instance, the presence of ununited frontal bones—a normal feature in infancy—is used as an excuse for a 3-page dissertation on metopism in adult human beings and in other primates. Here the references go back to 1885.

The author, who is dean of the faculty of sciences at the University of Poitiers, does not clearly separate information about his own specimens from that of the authorities he cites. In fact, on going through the nearly five pages on the status of the sutures, I find less than a



dozen scattered lines (sometimes only clauses) describing the Pech de l'Azé specimen. This does not mean that the new information is scanty, for later on 53 measurements and 26 indices are listed for the skull, and these are discussed at length in 26 pages of text!

Really, this is a very welcome addition to our knowledge, and my complaint is not about the amount of information provided but about the way in which it is presented. The reader will find it very difficult to piece together the descriptions of the two infants. Some of the space might better have been used for the illustrations. The eight plates are overly crowded, and this makes the individual pictures too small. Besides, the legends for the plates are too brief.

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**The Testing of Negro Intelligence.** Audrey M. Shuey. J. P. Bell, Lynchburg, Virginia, 1958. 351 pp. \$4.

Representing the most exhaustive literature survey of the intelligence-test performance of American Negroes yet attempted, this book covers over 300 references that appeared between 1913 and 1957. Of these, approximately 170 are published reports of original investigations, 71 are unpublished master's or doctoral dissertations, and the remainder include reviews, critiques, and other interpretative discussions. Except for one Canadian and one British West Indies study, all data were obtained on Negroes living in the United States. Research results are presented in the form of summary tables and text discussion, one chapter being devoted to each of the following: young children (primarily in nursery schools and kindergartens), school children, high-school and college students, the armed forces, deviates (including gifted and retarded), delinquents and criminals, racial hybrids, and selective migration. All varieties of intelligence tests are covered, including group, individual, verbal, nonverbal, performance, and "culture-fair." A few studies utilizing multiple-factor batteries, such as the tests of Primary Mental Abilities, and special aptitude tests, such as the Minnesota Paper Form Board, are likewise reported.

Despite the meticulous care with which minutiae were ferreted out, the treatment of certain studies may be such as to create misleading impressions. For example, in discussing D'Angelo's study (pp. 12, 16, 22), in which no significant Negro-white difference in Draw-a-Man IQ was found, Shuey concludes that the results are uninterpretable because the subjects were selected by nursery direc-

tors and did not comprise all cases meeting the age and language specifications. In actual fact, all children who met these two requirements were tested, the nursery directors merely providing the names of those who fulfilled these specifications. It is also difficult to understand why reference is made to D'Angelo's unpublished dissertation but not to the later article, by Anastasi and D'Angelo in the *Journal of Genetic Psychology* (1952), which covered more cases and provided more refined statistical analyses. Similarly, in discussing a study by Boger (pp. 68, 77, 110, 122-3), Shuey fails to mention that intelligence-test scores of Negro children improved more than those of whites as a result of perceptual training. Only the performance of both groups prior to training is reported.

On the whole, Shuey's survey serves only to document the old familiar finding that whites usually excel Negroes in mean intelligence-test scores, although overlapping is extensive and all levels of test performance can be found in both groups. With these purely descriptive facts few psychologists have ever taken issue. The major differences have centered around interpretation. Although Shuey concludes that the data "point to the presence of some native differences between Negroes and whites as determined by intelligence tests" (p. 318), few of the studies shed even a glimmer of light on causal factors, and their results are at least equally consistent with an environmental interpretation of group differences.

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**Agricola on Metals.** The age of technology waited for better and more abundant metals; it arrived so much sooner because Agricola published *De Re Metallica*, a mining and metallurgical classic. Bern Dibner. Burndy Library, Norwalk, Conn., 1958, 128 pp.

Bern Dibner celebrates the third International Geophysical Year by reducing to a 100-page summary the 600 pages of the Hoovers' translation of *De Re Metallica*. He has presented a straightforward statement of Agricola's observations and theories in their historical context, the Hoover footnotes being, in effect, incorporated in the text. His introductory chapters provide a neat defense of Agricola and his works.

There is much to be said for digesting a classic such as *Agricola* in order to make available a complete presentation of the text for those who otherwise find the Hoover volume inaccessible or too expensive, or who seek information about

the background of the well-known woodcuts; but it is hoped that *Agricola on Metals* will not entirely replace *De Re Metallica* on the reference shelves, since it would be a pity if the painstaking scholarship of the Hoovers were forgotten.

The plates reproduced are well chosen and representative, though they would have been improved if Dibner's useful explanatory notes had been added to the original captions.

I would question Dibner's explanatory subtitle and ask, How much sooner did the age of technology arrive because Agricola published *De Re Metallica*? Before the Hoovers revived the book in 1912, there had apparently been no edition of *Agricola* since 1687. The German translation prior to that of 1928 was, according to Hoover, "a wretched work by one who knew nothing of the science" and who was clearly unqualified to unravel the technical mysteries of the original text. *De Re Metallica* could hardly have been a vade mecum for the practical man, even in Germany. If it had been popular, one would expect to find a record of frequent republication and revision, just as Andrew Ure's *Dictionary of Arts, Manufactures and Mines* was kept more or less up to date in the early days of the 19th century. No evidence is presented by Dibner that this happened. One suspects that while *De Re Metallica* now provides us with a useful account of the state of the art at the end of the 16th century, the work had little or nothing to do with technological progress of the period. Though it may have helped to spread knowledge of the operating techniques described, the more aggressive miners and smelters probably went on with their job of improving, modifying, and sometimes innovating, little affected by Agricola's report. There is room for more research in the history of 17th- and 18th-century mining and mineral processing before it can be confidently assumed that Agricola did, in fact, accelerate technological advance.

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**Applied Differential Equations.** Murray R. Spiegel. Prentice-Hall, Englewood Cliffs, N.J., 1958. xv+381 pp. Illus. \$6.75.

This book would serve, and serve well, as a text for a beginning course in elementary ordinary differential equations. The usual special types of first and higher ordered equations are treated. Single and simultaneous equations with constant coefficients come next; then series solutions and a brief chapter on

numerical methods. Two final chapters relate to the origin of partial differential equations and the solution of boundary-value problems by Fourier series.

The logical and pedagogical presentation is handled with skill. Basic problems of existence and uniqueness are pointed out and disposed of by quoting theorems, with appropriate reference to proofs elsewhere. In the treatment of applications, derivations of a number of equations are given in detail, based on physical principles.

The collection of up-to-date practical problems is excellent. Numerous exercises with answers are given in each chapter; these fall into three categories: standard drill problems; more interesting, involved problems; and problems intended to broaden the scope of the text.

I would like to have seen a chapter stressing geometrical aspects. The sketching of integral curves in the phase plane by the method of isoclines would have led at once to a discussion of nodes, centers, foci, and so on. Questions of stability, existence of limit cycles, and so forth, would come next, all treated qualitatively and to some extent intuitively.

The questionable and long-standing practice of presenting something on partial differential equations in a text such as this, which, in my opinion, really should be devoted to ordinary differential equations, is followed here. Space which could have been devoted to such topics as Hurwitz stability criterion, asymptotic series solutions, further details on numerical methods, and geometry is lost.

A little amplifying by the instructor along the lines indicated should make this book, however, a most satisfactory text.

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**Human Infertility.** C. Lee Buxton and Anna L. Southern. With a chapter on endometrial diagnosis by Earl T. Engle. Harper, New York, 1958. x + 229 pp. Illus. \$7.50.

This little volume was written by authors well known for their contributions in the field of involuntary infertility—medical doctors who were trained where exposure to basic research in the physiology of human reproduction was inescapable.

The diagnosis and treatment of the infertile couple is complicated, first by the fact that sterility concerns two individuals, not one. In this book the major attention is given to the female partner; the importance of examination of the

male is emphasized, but treatment of the infertile husband the authors leave to the urologist.

Many variables are involved in a diagnosis of sterility; this renders research only partially susceptible to rational statistical analysis. Enough statistics are given in this book to enable the physician roughly to estimate the effect of his treatment; the difficulty of evaluating different types of treatment is increased where the follow-up reveals the fact that, whether the patient is treated or not, the cumulative percentage of "cures" gradually increases, either spontaneously or as a result of treatment, at least for 10 or 12 years.

Much is made of the psychological factor. The beneficial effect merely of the quieting assurance of the wise physician has been noted by many. The rather surprising finding that the greatest percentage of pregnancies in the authors' study population of some 2000 patients occurred during the first months of investigation implies that factors other than treatment are at work. The conservatism implicit in this statement is characteristic of the book. While cautioning against undue enthusiasm with respect to corrective measures employed, the authors proceed to evaluate the therapeutic measures which, research has shown, bring about a certain percentage of cures. For the general reader of *Science* the book gives a brief and authoritative clinical abstract of the sterility problem.

For the general reader, too, the authors present as background the basic physiological processes in human reproduction. There is a chapter on the methods of diagnosing whether or not ovulation takes place—methods that depend on basal body temperature, determination of urinary pregnanediol, and endometrial biopsy. To help evaluate the last method, there is included a chapter on "Endometrial interpretation," by the late Earl T. Engle, to whom the book is dedicated as the authors' "guide, friend and preceptor."

For the physician, the current methods of diagnosing causes are presented and evaluated in the light of the authors' not inconsiderable experience over a decade.

As the results of tests for ovulation give information on the endocrine status of the sterile woman, particularly with reference to the pituitary gland, the ovaries, the adrenal cortex, and the thyroid, the activity of these glands is carefully evaluated. The clinical importance of the *cervix uteri* for the entrance of spermatozoa and the patency of the fallopian tube, through which sperms must ascend to the ampulla and through which the egg descends to the uterus, are discussed in detail.

The role of prenatal death of the ovum due to genetic causes is not mentioned, probably because there is nothing one can do about it, and stimulation of a laggard ovary by irradiation is not endorsed because "geneticists advise against this type of therapy."

In the chapter on the sociological implications of efforts to correct sterility, the authors point out that such efforts concern the individual's right to have children, if it is at all possible, and that medical help in this direction will have no great impact on the frightening demographic problem of overpopulation that faces the world.

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**Principles of Physical Chemistry.** An introduction to their use in the biological sciences. Wallace S. Brey, Jr. Appleton-Century-Crofts, New York, 1958. vii + 433 pp. Illus. \$7.

Intended as a textbook to be used in a one-semester course for premedical students, this book is strengthened in that purpose by limited examples in which physicochemical principles are applied to biology. Consistent with the objective is the serious attempt to employ only the simplest mathematical operations. In a few cases, this causes fundamentally easy derivations to appear complex, but usually the author has achieved his desired effect of inspiring confidence in the validity or reasonableness of equations without the tedium or complication of detailed development.

The book is about half as long as most of today's textbooks in physical chemistry. This has required that there be deletions or extreme brevity in some fields. There is nothing about the phase rule, solid solutions, or eutectics and very little about the solid phase. Except for solutions of electrolytes, the treatment of homogeneous equilibrium is fragmentary; the kinetics of heterogeneous equilibrium are omitted altogether. Even more surprising, in a book for biologists, is the confinement of photochemical reactions within one short sentence. The discussion of photosynthesis is separate and almost as brief. Nevertheless, these are prices that must be paid to reach a group who never try very hard to learn physical science. Despite the exceptions mentioned, nearly all customary topics have been included and accorded adequate treatment.

The author appears not to acknowledge the jurisdiction of the General Conference on Weights and Measures or the national standardizing laboratories to determine the temperature scale. He gives

the triple point of water as 0.0098°C, although the Ninth General Conference on Weights and Measures (1948) adopted [Science 109, 100 (1949)] and the Tenth Conference (1954) reaffirmed [Science 120, 1008 (1954)] the triple point of water as 0.0100° Celsius (centigrade), thus displacing, as a fundamental fixed point, the inexact and ill-defined freezing point of water under atmospheric conditions.

Brey has fine gifts for direct, clear, and interesting exposition. Except in those chapters where the condensation has caused a sense of breathless haste, the treatment moves forward smoothly, faultless language serving to establish the degree of comprehension that the writer has deemed reasonable. The purposes of the book are good, and minor technical imperfections of fact or treatment do not seriously detract or keep it from presenting physical chemistry in a way that will specifically suit the early student of biological science.

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## New Books

*Electronic Measuring Instruments.* E. H. W. Banner. Macmillan, New York, ed. 2, 1958. 512 pp. \$7.95.

*Selected Writings of John Hughlings Jackson.* vol. I, *On Epilepsy and Epileptiform Convulsions.* vol. II, *Evolution and Dissolution of the Nervous System.* Speech. *Various Papers, Addresses and Lectures.* James Taylor, Ed. Basic Books, New York, 1958. 514 pp.; 518 pp. \$15 per set.

*The Evolution of Development.* Three special lectures given at University College, London. John Tyler Bonner. Cambridge Univ. Press, New York, 1958. 110 pp. \$3.50.

*Psychopharmacology.* Pharmacologic effects on behavior. Harry H. Pennes. Hoeber-Harper, New York, 1958. 375 pp. \$8.

*We, the Tikopia.* A sociological study of kinship in primitive Polynesia. Raymond Firth. Allen & Unwin, London, ed. 2, 1958 (order from Macmillan, New York). 631 pp. \$7.50.

*Thinking.* An experimental and social study. Basic Books, New York, 1958. 203 pp. \$4.

*Borradaile's Manual of Elementary Zoology.* Revised by W. B. Yapp. Oxford Univ. Press, New York, 1958. 777 pp.

*Frontiers in Science.* A survey. Edward Hutchings, Jr., Ed. Basic Books, New York, 1958. 362 pp. \$6.

*Language, Thought, and the Human Mind.* Chester A. Lawson. Michigan State Univ. Press, East Lansing, 1958. 117 pp. \$4.50.

*Langenscheidts Fachwörterbuch Wehrwesen.* Englisch. Englisch-Deutsch. Deutsch-Englisch. Friedrich Krollmann. Philosophical Library, New York; Langenscheidt, Berlin, 1957. \$10.

*The Evolution of Genetic Systems.* C. D. Darlington. Basic Books, New York, rev. ed. 2, 1958. 275 pp. \$5.50.

*Structure and Evolution of the Stars.* Martin Schwarzschild. Princeton Univ. Press, Princeton, N.J., 1958. 314 pp. \$6.

*Textbook of Organic Chemistry.* Carl R. Noller. Saunders, Philadelphia, ed. 2, 1958. 664 pp.

*Upper Cretaceous of the Pacific Coast.* Memoir 71. F. M. Anderson. Geological Soc. of America, New York, 1958. 378 pp.

*Biology and Human Progress.* Louis Eisman and Charles Tanzer. Prentice-Hall, Englewood Cliffs, N.J., ed. 2, 1958. 560 pp.

*Experimental General Chemistry.* J. W. Neckers, T. W. Abbott, K. A. Van Lente. Crowell, New York, ed. 3, 1958. 325 pp. Paper, \$3.50.

*The Study of Comparative Government and Politics.* Gunnary Heckscher. Macmillan, New York, 1957. 172 pp. \$4.25.

*A Critical Review of the Techniques for Testing Insecticides.* J. R. Busvine. Commonwealth Inst. of Entomology, London, 1957. 208 pp. 30s.

*Theory of Psychoanalytic Technique.* Menninger Clinic Monogr. Ser. No. 12. Karl Menninger. Basic Books, New York, 1958. 219 pp. \$4.75.

*Experiments in Physical Science.* Allen D. Weaver and James F. Glenn. Brown, Dubuque, Iowa, 1958. 196 pp. \$3.

*Actions chimiques et biologiques des radiations.* "Radiolyse de liquides organiques," Milton Burton; "Polymérisation amorcée par les radiations ionisantes," A. Chapiro and M. Magat; "Effets des rayonnements de grande énergie sur les polymères," A. Charlesby. Masson, Paris, 1958. 222 pp.

*Teaching High School Science: A Book of Methods.* Paul F. Brandwein, Fletcher G. Watson, Paul E. Blackwood. Harcourt, Brace, New York, 1958. 598 pp.

*Principles of Geochemistry.* Brian Mason. Wiley, New York; Chapman & Hall, London, ed. 2, 1958. 317 pp. \$8.50.

*Foundations of Information Theory.* Amiel Feinstein. McGraw-Hill, New York, 1958. 147 pp. \$6.50.

*The Origins of the English Library.* Raymond Irwin. Allen & Unwin, London, 1958 (order from Macmillan, New York). 255 pp. \$4.50.

*Foundations of Embryology.* Bradley M. Patten. McGraw-Hill, New York, 1958. 594 pp. \$9.50.

*Electronic Instrumentation for the Behavioral Sciences.* Clinton C. Brown and Rayford T. Saucer. Thomas, Springfield, Ill., 1958. 174 pp. \$5.50.

*African Economic Development.* William A. Hance. Harper (for the Council on Foreign Relations), New York, 1958. 317 pp. \$4.95.

*Les Limitations internes des formalismes.* Etude sur la signification du théorème de Gödel et des théorèmes apparentés dans la théorie des fondements des mathématiques. Jean Ladrière. Nauwelaerts, Louvain, Belgium; Gauthier-Villars, Paris, 1957. 728 pp. Bel. F. 650.

*A Primer of Cerebral Palsy.* Joseph D. Russ and Hyman R. Soboloff. Thomas, Springfield, Ill., 1958. 77 pp. \$4.

## Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

*Le Climat Pluviométrique des Basses Cévennes.* Monographies de la Météorologie Nationale, No. 7. R. Rebotier. 28 pp. *Prévision du Temps sur le Bassin du Congo.* Monographies de la Météorologie Nationale, No. 9. G. Jeandidier and P. Rainteau. 13 pp. Ministère des Travaux Publics, des Transports et du Tourisme, Paris, 1957.

*ECPD, 25th Annual Report for the Year Ending September 30, 1957.* Engineers' Council for Professional Development, New York 18, 1958. 79 pp. \$1.

*Licht, Materie, Weltall im Einheitlichen Naturbild.* Ewald Helmut Lupfert. Birkenkopf, Stuttgart, Germany, 1958. 76 pp. DM. 4.

*Plant Physiology.* Laboratory exercises. Paul C. Lemon. Brown, Dubuque, Iowa, 1958. 171 pp. \$3.

*1958 Heat Transfer and Fluid Mechanics Institute.* Preprint of papers. Held at University of California, Berkeley, 19-21 June 1958. Stanford Univ. Press (for the Heat Transfer and Fluid Mechanics Inst.), Stanford, Calif., 1958. 264 pp. \$8.50.

*Development, Growth, and State of the Atomic Energy Industry.* Hearings before the Joint Committee on Atomic Energy, Congress of the United States, Eighty-Fifth Congress, Second Session. Joint Committee on Atomic Energy, Washington, 1958 (order from Supt. of Documents, GPO, Washington 25). 624 pp.

*School Finance and School Business Management.* Responsibilities and Services of State Departments of Education. Misc. No. 29. Clayton D. Hutchins, Albert R. Munse, Edna D. Booher. U.S. Office of Education, Washington, 1958 (order from Supt. of Documents, GPO, Washington 25). 78 pp. \$0.60.

*Distribution of Meteoritic Debris about the Arizona Meteorite Crater.* Contrib. to Astrophysics, vol. 2, No. 7. John S. Rinehart. 16 pp. \$0.20. *Orbital Data and Preliminary Analyses of Satellites 1957a and 1957b.* Contribs. to Astrophysics, vol. 2, No. 10. Compiled by F. L. Whipple, L. G. Boyd, J. A. Hynek, G. F. Schilling. 50 pp. \$1. Smithsonian Institution, Washington 25, 1958 (order from Supt. of Documents, GPO, Washington 25).

*Health Statistics: Origin and Program of the U.S. National Health Survey.* A description of the developments leading to enactment of the National Health Survey Act, and a statement of the policies and initial program of the survey. 36 pp. \$0.25. *Health Statistics: Preliminary Report on Numbers of Persons Injured, United States, July-December 1957.* Statistics on the number of persons injured, the number of days of disability due to injuries, and class of accident. Based on data collected in household interviews during July-December 1957. 32 pp. \$0.30. U.S. Department of Health, Education, and Welfare, Washington, 1958 (order from Supt. of Documents, GPO, Washington 25).



# Reports

## Caries Experience in Twins

Despite widespread and persistent speculation that susceptibility to dental caries in man is a heritable trait, limited data support this belief. Studies of inherited variation in human dental caries experience have produced conflicting findings. Studies of young subjects (1) have shown only slight differences in the average intrapair variation in caries experience between monozygotic and dizygotic twins. In data obtained with adults (2), however, the mean intrapair difference observed for dizygotic twins was four times as great as that observed for monozygotic twins.

Investigations of susceptibility, or resistance, to dental caries in parents and offspring (3) and in siblings (4) have generally substantiated the concept of a familial pattern in caries incidence. A critical review of the literature on the relationship of heredity and caries incidence has been presented by Böök and Grahnén (5), whose original data on caries-free propositi indicated that genetic factors played an appreciable part in determining individual resistance to dental decay.

Presumably, both environmental and genetic factors are responsible for the initiation of the caries lesion. For genetic problems of this nature, the study of twins offers a suitable investigative procedure and has been utilized in the present investigation.

The study sample consisted of 49 like-sexed pairs of Caucasian twins in good general health, drawn mainly from middle-income residents in New York City. The ages ranged from 18 to 55 years at the time of the study, with the median age 24 years. The diagnosis of zygosity was based on serological and morphological criteria (6).

The single tooth surface is considered

the unit of measurement most appropriate for caries studies of a limited number of subjects (7). Using the method of Klein, Palmer, and Knutson (8), we assigned each decayed or filled surface a score of 1 and each tooth missing as the result of caries a score of 5. It is necessary in small-sample studies to account for teeth which through failure to erupt or congenital absence were never available for decay. Teeth lost through trauma or periodontal disease also bias the results if it is assumed that they were extracted because of caries. For these reasons a caries experience ratio (CER) was determined for each subject in the following manner:

$$CER = \frac{\text{Observed No. of decayed, missing, or filled surfaces}}{\text{Total No. of surfaces originally available for decay (based on 28 teeth, 128 surfaces)}}$$

The use of this ratio makes it possible to subtract an appropriate amount for teeth determined by a clinical history to be missing for reasons other than caries. The total number of decayed, missing, or filled surfaces (DMFS) for the permanent teeth of each subject was determined by means of a clinical examination performed with a mouth mirror and a No. 23 dental explorer, supplemented by a full-mouth series of intraoral roentgenograms. As calculated, the CER represented the total amount of destruction caused by dental caries in the permanent dentition up to the time of the study.

In addition to the CER for the total dentition, ratios were computed separately for different groups of teeth. To obtain these ratios, the appropriate DMFS value was related to the number of surfaces available for attack—that is, 30 in the case of the six anterior teeth (incisors and canines), and 40 for the eight posterior teeth.

A comparison of the mean difference in CER between the two members of dizygotic twin pairs and that between the two members of monozygotic twin pairs was made on the basis of mean intrapair variances. Variance ratios were calculated, and the *F* distribution was used to obtain the significance level of these ratios (Table 1).

The comparison of the CER of monozygotic with dizygotic twin pairs indicates that there is a measurable genetic component of susceptibility to dental

caries. These data confirm the results of the only prior study of caries experience in adult twins (2). The discrepancy between the results of studies of adult and juvenile twins suggests that in all probability a hereditary factor in dental caries experience cannot be readily measured until eruption of the permanent teeth is essentially complete.

Comparison of the mean intrapair variances in CER in the four segments of the dentition permits an evaluation of each upon the total difference in CER. The lower anterior tooth group contributes the most to the total difference between monozygotic and dizygotic twins. It has been shown by Knutson *et al.* (9) that the lower anterior teeth experience relatively little caries attack, less than any other group. However, this does not permit interpretation of the results of the present study as evidence for a genetic difference in caries susceptibility for the different regions of the dentition, but only indicates that in the area of the lowest caries incidence a genetic component of variability may be measured more readily. Where environmental variation is relatively high, it becomes difficult to make this distinction. It is of interest that the upper anterior teeth, which show the smallest difference between monozygotic and dizygotic twins, normally receive less saliva flow than teeth in the other segments of the mouth. In contrast, the lower anteriors, which provide the largest ratio, are subject to copious saliva flow, being located in an area into which the ducts of the submaxillary and sublingual glands open. Consequently, it appears possible that some genetic characteristic of saliva may be partially responsible for the variations observed in caries experience.

By use of the caries experience ratio (CER), it is possible by study of twins to demonstrate a genetic component of

Table 1. Caries experience ratios. Dz, dizygotic twins; Mz, monozygotic twins.

Group	<i>n</i> (pairs)	Variance	<i>F</i>	<i>P</i>
<i>All teeth</i>				
Dz	13	78.81	2.74	< .025
Mz	22	29.11		
<i>Upper anterior teeth*</i>				
Dz	17	58.68	1.57	> .10
Mz	27	37.32		
<i>Upper posterior teeth†</i>				
Dz	17	248.12	2.64	> .01
Mz	26	93.92		
<i>Lower anterior teeth*</i>				
Dz	19	45.16	5.55	< .001
Mz	30	8.13		
<i>Lower posterior teeth†</i>				
Dz	15	155.53	2.48	.025
Mz	25	62.80		

\* Central and lateral incisors, canines.

† First and second premolars, first and second molars.

All technical papers are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).



variability in the caries incidence of adults in essentially good health. This lends added support to the hypothesis that there is a hereditary factor in susceptibility to caries.

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### Life-Shortening by Whole- and Partial-Body X-irradiation in Mice

The fact that ionizing radiations, in whole-body doses which cause little or no immediate morbidity, shorten the life span of animals has been demonstrated in many experiments. With such evidence as a background, it has been argued that *partial-body* exposure, in man as well as in experimental animals, would have a life-shortening effect in strict proportion to exposure dose or integral dose (1). Although this concept is misleading for a variety of theoretical reasons, specific experimental evidence relating to life-expectancy after partial-body exposure has not previously been available.

The present data, taken from an experiment designed for another purpose (2), illustrate the different potencies of partial- and whole-body x-ray exposure in shortening the life of the mouse. Uniparous female CAF<sub>1</sub> mice (the F<sub>1</sub> generation from the cross, BALB/c females  $\times$  A/He males) were irradiated at 170 days of age and  $26.0 \pm 1.4$  g body weight. The radiological factors were 250-kvcp x-rays, HVL of 0.55 mm Cu; whole-body exposure dose rate in tissue, 73 r/min; partial-body exposure dose rate in tissue, 53 r/min.

All mice received only a single x-ray dose, with the exception of the 1200-r whole-body treatment which was given as four 300-r fractions 2 weeks apart. All groups (Table 1) were irradiated or sham-irradiated while under moderate

Nembutal anesthesia. The whole-body doses were given as described previously (3). Mice to be exposed to partial-body irradiation were placed on their backs on 1/16-in. lead sheet, fixed in place with masking tape, and shielded from above (over their ventral surfaces) with 1/8 in. lead sheet. Three different partial-body fields were used: (i) bilateral thorax—from clavicles to tip of xiphoid process; the weight of the tissue irradiated in this field averaged approximately 7.6 g. (ii) Right hemithorax—same as i except for shielding over the left half of the chest; mean irradiated weight, 3.5 g. (iii) Pelvis—the region posterior to a line 1.5 cm anterior to the base of the tail; mean irradiated weight, 5 g.

The exposure doses in tissue given in Table 1 were estimated by placing the sensitive volume of a 100-r Victoreen ionization chamber, surrounded by rice bolus, in a typical exposure field. The dose in the shielded regions was no greater than 4.4 percent of that in the exposed fields, as determined by placing ionization chambers at different points under the shielding while tissue-equivalent bags of rice were being irradiated in the exposure fields. Half the mice receiving 1800 r of partial-body irradiation were irradiated to the right thorax only, the other half to the pelvis as well.

Most of the animals were allowed to die spontaneously, but some (22 percent) were sacrificed when they were moribund. Except the 1200-r whole-body group in which the first death occurred 85 days after the final 300-r fraction, there were no deaths before 169 days postirradiation. Consideration of the data in Table 1 leads to the following comments.

**Whole-body exposure.** Three hundred roentgens and 560 r both shortened life significantly and to about the same extent. In consequence, the decrement in life span per 100 r (Table 1) is greater at the lower dose. The phenomenon of increased sensitivity of female mice per unit dose, as dose decreases in the range from 600 to 200 r, has been noted previously (4, 5). It has been suggested (5) that this is somehow related to the peculiarly great sensitivity to x-rays of the mouse ovary.

**Partial-body exposure.** Per unit of tissue dose, partial-body exposure to the pelvis or chest, or both, was much less effective than whole-body exposure, especially after 300 to 750 r.

**Small and large doses.** In the whole-body experiments the smallest dose was more effective per unit dose than the larger ones. The smaller partial-body exposures, however, were less effective per unit dose than the larger ones. (The ovaries were not within the fields of partial-body exposure.) Extrapolation of the data for partial-body exposure suggests that, at still lower doses—for example, 100 r—the effectiveness per unit dose may be so reduced as to be negligible. It is of interest to note that doses tested in the present study are hundreds to thousands of times greater than those used in human radiological diagnosis (6). Moreover, the total dose built up from repeated diagnostic exposures is fractionated and therefore presumably of diminished effectiveness.

**Integral doses.** Per unit integral dose, whole-body exposure may shorten life more or less than partial-body exposure, as is shown in the last column of Table 1. In the case of partial-body exposure to one region, the decrement in life span

Table 1. Survival of female mice after whole-body (WB) and partial-body (PB) exposure.

Treatment	Integral dose (kg r)	No. of mice	Mean survival time $\pm$ SE (days)*	Decrement in life span per unit dose	
				day/100 r	day/kg r
Control		34	676 $\pm$ 25		
300 r, WB	7.8	35	549 $\pm$ 24	42	16
560 r, WB	14.6	43	556 $\pm$ 23	21	8
1200 r, WB					
(4 $\times$ 300 r)†	31.2	43	429 $\pm$ 21	21	8
750 r, bilateral thorax	6.3	34	661 $\pm$ 26	2	2
1800 r, right thorax	7.7	20	567 $\pm$ 39	6	14
600 r, right thorax + pelvis	5.6	38	660 $\pm$ 23	3	3
1200 r, right thorax + pelvis	11.1	40	583 $\pm$ 28	8	8
1800 r, right thorax + pelvis	16.7	20	501 $\pm$ 37	10	10

\* Mean ages may be determined by adding 170 to the mean survival times. SE, standard error of the mean survival time.

† The tabulated figures referring to survival and life span decrement are based on the time elapsed from the beginning of irradiation. Computed from the day on which the final 300-r fraction was given, the last 3 columns of this row would read 387  $\pm$  21 days, 24 days/100 r, and 9 days/kg r, respectively.

per unit dose was not constant. To understand the various results, each must be considered on the basis of the particular lesions involved.

The present data indicate how varied the life-shortening effects of partial- and whole-body exposure can be and the difficulties in attempting to extrapolate from one to the other. They also indicate how tenuous the quantitative estimates of life shortening in man must be when they are based on the relatively incomplete data currently available for experimental animals.

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10 March 1958

### New Marine Horizon in the Conemaugh Formation

In the course of stratigraphic studies of the Pennsylvanian sediments of the Kiskiminetas Valley in western Pennsylvania, I have found a previously unrecognized marine shale in the Conemaugh formation. The name "Carnahan Run shale" is proposed for the new stratum, and the designated type locality is in Parks Township, Armstrong County, Pennsylvania, about 0.7 mile north of North Vandergrift.

The fossiliferous shale is found in an outcrop along a country road on the north slope of the first fork of Carnahan Run, about 0.1 mile southeast of Carnahan Run. At the type locality the shale is 5 feet in thickness, weathers brown, and is dark grey on fracture. The rock is calcareous, with numerous small flecks of mica. The new horizon is separated from the underlying Woods Run limestone of Raymond by 21½ feet of reddish-brown shale that carries fragments of fossil plants. There is no marked break in sedimentation between the Carnahan Run marine bed and the underlying shale. A similar reddish-brown shale is found above the Carnahan Run shale at the type locality, but a layer of yellow clay about 1 inch in thickness intervenes between the two

beds. At the outcrop, in the Carnahan Run shale, the fossils are for the most part preserved as molds; the calcium carbonate of the original shells has been leached out. Recognized species include the brachiopod *Juresania nebrascensis* and a gastropod, *Amphiscapha elli* n. sp.

The Carnahan Run shale has also been noted in roadside exposures adjoining Pennsylvania State Highway Alternate 66 on North Vandergrift Hill, about 0.7 mile northeast of North Vandergrift, and approximately 0.5 mile from the type locality. There the marine shale is 1½ feet in thickness and is separated by 23½ feet of reddish-brown shale from the Woods Run limestone of Raymond, which outcrops below. Three inches of ferruginous clay separates the Carnahan Run shale from the overlying shales. The Ames limestone outcrops 126 feet above the Carnahan Run shale in this section, and the roof of the Upper Freeport coal, which marks the lower limit of the Conemaugh formation, is found 216 feet below the base of the new marine bed. Molds of *Amphiscapha elli* n. sp. are characteristic fossils in the Carnahan Run shale at this locality.

At Gosser Hill, in Westmoreland County, across the river from Leechburg, Pennsylvania, about 2.7 miles west of the type locality, the Carnahan Run bed is 7 feet in thickness. At this place it is found 13½ feet above the Woods Run limestone of Raymond and occurs approximately 226 feet above the Upper Freeport coal. Fossils are numerous and well-preserved in the Carnahan Run shale at this locality; the exposure was found in a recent excavation, and the shells have not been leached out.

Prior to dealing with the Carnahan Run shale in relation to the marine limestones which intervene between it and the underlying Lower Bakerstown coal, I find it necessary to touch upon the nomenclature of the latter marine beds. Two limestones have been distinguished in this interval. One, the original Woods Run limestone, was named by Raymond (1) in 1910, and its type locality was designated as Woods Run, in what is now Pittsburgh, Pennsylvania. In 1929, Johnson (2) described a second limestone which in the Pittsburgh region occurs approximately 8 to 17 feet below the Woods Run limestone, but he did not name the bed or indicate a type locality. Subsequent workers have sometimes referred to the two strata as the Woods Run limestones or have distinguished them as the Upper and Lower Woods Run limestones.

To avoid confusion, I feel that the original name Woods Run should be retained, without modification, for the limestone which Raymond described in 1910, especially since it is now known

that in some localities another marine bed, the Carnahan Run, closely overlies the Woods Run limestone of Raymond. For the limestone described by Johnson, which underlies the Woods Run, I propose the new name "Nadine limestone," and designate as the type locality Nadine, on the Allegheny River east of Pittsburgh, where its occurrence was noted by Johnson. To Johnson's description it may be added that the Nadine limestone carries marine fossils at the type locality, including the distinctive brachiopod *Chonetina flemingi plebia*.

The characteristics and relationships of the Carnahan Run shale, Woods Run limestone, and Nadine limestone in the Kiskiminetas Valley may be summarized as follows:

The Carnahan Run is a calcareous marine shale, 1½ to 7 feet in thickness, which is found about 126 feet below the Ames limestone, 13½ to 23½ feet above the Woods Run limestone, and approximately 216 to 226 feet above the Upper Freeport coal. Marine fossils noted to occur at this horizon include *Juresania nebrascensis*, *Meekospira peracuta*, *Pharkidonotus percarinatus*, *Metoceras* sp., and *Amphiscapha elli* n. sp.; the latter species is abundant and characterizes the stratum.

The Woods Run is an impure, nodular, ferruginous limestone, ½ to 1½ feet thick. It outcrops approximately 151 feet below the Ames limestone, 18 to 20 feet above the Nadine limestone, and about 191 to 212 feet above the Upper Freeport coal. The bed is sparingly fossiliferous, with *Lophophyllidium proliferum* the commonest species, although *Shan-siella carbonaria*, *Solenocleilus* sp., and *Ameura* sp. have also been noted at this horizon.

The Nadine is a relatively pure limestone, light to dark grey on fracture, 4 inches to 1½ feet thick. In outcrops in the vicinity of North Vandergrift, Pennsylvania, it occurs approximately 172 feet below the Ames limestone, 32 feet above the Cambridge limestone and 170 feet above the Upper Freeport coal. Marine fossils are not abundant, but *Chonetina flemingi plebia* is the commonest species and has been recognized at all outcrops of the limestone in the Kiskiminetas Valley. Associated forms include *Derbya crassa*, *Punctospirifer kentuckiensis*, *Neospirifer triplicatus*, *Marginiifera splendens*, and *Rhombopora lepidodendroides*.

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30 September 1957.

## Effect of Aspirin on Suprathreshold Pain in Man

Beecher, in his extensive review on the measurement of pain (1), came to the conclusion that experimental pain in man, as used at present, is not suitable for appraisal of analgesic agents. For investigators interested in the physiology of pain, the evaluation of analgesic agents is a side issue. However, something must be wrong with our concept of pain if the investigator thinks that he can use experimental pain for evaluation of analgesic agents even though practical experience shows that it is not suitable for that purpose. Experimental pain may be different from clinical pain; still it might provide useful information if we realize that it is different and know why.

Beecher (1) also pointed out that experimental pain in animals can be used for evaluation of potent analgesic drugs. If an injurious stimulus is applied to an animal, a skin twitch, a tail flick, or a withdrawal reaction may be observed. These are spinal reflexes and therefore are side effects of pain. They are even undesirable side effects, for an ideal analgesic agent should eliminate pain without affecting reflex activity. Potent analgesics can be tested by this type of procedure because they are not specific for pain. This explains the failure of weak analgesic agents in tests of animals. It does not explain the failure of experiments with human beings.

In a recent investigation in which Hardy's thermal radiation method (2) and double-blind technique were used in man, no difference was found between the effect of 10 grains of aspirin on the pain threshold and that of a placebo (3). Pain threshold is fairly stable from individual to individual and is independent of age, sex, race, and emotion (4). However, all available evidence indicates that the suffering produced by an equally injurious stimulus varies markedly (1). This shows that the determination of pain threshold involves only one aspect of the total pain complex, which might be called pain perception. If the effect of aspirin were on the mechanism of pain perception, we would expect a rise of pain threshold. If aspirin affected the reaction component of pain (1) we might not see any effect on the pain threshold, while at greater pain intensities the effect might come out.

This idea was tested in a series of 32 experiments in which four types of pain and double-blind techniques were used. The 16 subjects were males 21 to 44 years of age. Pain was produced by the following procedures:

1) The hand was immersed in ice water. This produces marked pain which increases to a peak within about 20 seconds. After that there are irregular fluctuations until the pain intensity decreases after about 60 seconds. For evaluation the time of occurrence of this peak was used as well as the pulse rate 60 to 75 seconds after immersion (control rate, 79.6 per minute).

2) Hardy's method of radiating the India ink painted volar side of the forearm with thermal radiation (200 mcal/sec/cm<sup>2</sup>) was used (2). The final skin temperature was calculated from the initial skin temperature, the known radiation intensity, and the measured time of exposure (2). Each subject was asked to determine his own intensity, which he considered as marked pain. Any further attempt to fix the stimulus intensity was avoided to allow free reign for the emotional aspect of pain. Two determinations were made for each test. The mean was taken as the test value for the experiment.

3) Contact heat was applied to the skin of the forearm with an instrument that allows heating of a small probe with simultaneous recording of the probe temperature (5). The probe was applied to the forearm. The heat was turned on, and the temperature was recorded when the subject reported that he had reached the pain intensity determined by procedure 2. Five determinations were made each time. The two extremes were eliminated, and the mean of the remaining three was considered as the test value.

4) A blood pressure cuff was applied to the upper arm and inflated to a pressure of 200 mm-Hg (6). Then the subject started pressing a Veeder counter rhythmically. The subject started with a fast rate but gradually slowed down, until finally ischemic pain made it impossible for him to go on. The number of clicks and the time were recorded. By dividing the number of clicks by the time, a ratio was obtained, the constancy of which appears to be a good indication of the subject's ability to reproduce the

same pain intensity. This means that an analgesic agent or at least aspirin will prolong the time and increase the number of clicks to the same extent, so that the ratio remains constant. Out of our 16 subjects four were experienced in this type of work and showed a very steady ratio. Of the other 12 subjects, five showed less than 5 percent change. These differences in evaluation were brought out by considering first the whole group of 16 subjects, then the nine subjects with good pain evaluation, and last the four trained subjects with the best ratios.

During the whole series care was taken not to mention any values or discuss any part of the experiment. In analysis each subject was considered his own control, and the percentage change after administration of aspirin was used as basis for the statistical evaluation.

The results are given in Table 1. Because of the inherent variability of the method, significant changes occur only with the ischemic contraction method of pain production. The number of contractions is increased and the time of continuing rhythmic contractions is prolonged, while the number contraction/time ratio remains the same. The difference between aspirin and placebo becomes more pronounced with the greater ability of the subject to evaluate pain objectively. As the tests using ice water and radiated heat show also an increased mean difference between the aspirin and the control group with better judgment on the part of the subject, this might be an indication that with an increased number of trained subjects the effect of a weak analgesic agent might become significant for other types of pain as well.

In spite of their limited success, our experiments indicate that the analgesic effects of aspirin can be demonstrated in the laboratory. Therefore, Beecher's objection might be justified as far as certain laboratory procedures are con-

Table 1. Effect of aspirin on four types of suprathreshold pain. A, aspirin; B, placebo; d, difference.

Pain	16 subjects, 32 tests			9 subjects with good judgment, 18 tests			4 trained subjects, 8 tests		
	A	B	d	A	B	d	A	B	d
Time of peak pain on immersion of hand in ice water (sec)	22.4	20.4	2.0	24.7	19.9	4.8	30.0	24.6	5.4
Radiation heat, final skin temperature (°C)	49.3	49.1	0.2	49.0	48.7	0.3	50.9	50.4	0.5
Pulse rate 1 min after immersion in ice water	84.3	85.9	1.6	84.3	86.4	2.1	84.0	80.2	3.8
Contact heat, final skin temperature (°C)	55.2	55.6	-0.4	55.1	56.0	-0.9	59.9	60.9	-1.0
Number of ischemic contractions	256	250	6.0	252	233	19	245	218	27
Significance (t test)		0.02			0.01			0.05	
Time of maintaining ischemic contractions (sec)	84.3	81.9	2.4	80.6	74.4	6.2	77.7	69.2	8.5
Significance (t test)		n.s.*			0.02			0.05	

\* Not significant.



cerned, but it does not refute the experimental approach to the main problem (7).

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### New Chromosome Number for the Order Caudata

During recent investigations of the chromosomes of the ambystomid salamanders occurring in the Pacific Northwest, it was found that one of the members of the family, *Rhyacotriton olympicus*, has a haploid chromosome number of 13; somatic tissues revealed a diploid number of 26. As far as can be determined from the literature (1), this constitutes a new chromosome number for the family Ambystomidae, and it is also the first such number recorded for the entire order Caudata. All other am-

bystomid salamanders known cytologically have  $n=14$ ,  $2n=28$ , as is summarized in Table 1.

The chromosome numbers for *Rhyacotriton olympicus*,  $n=13$ ,  $2n=26$ , were determined from counts in cells obtained from meiotic testes and from regenerating liver tissue. The material was prepared by a modification of the aceto-orcein squash technique of La Cour. *Rhyacotriton olympicus*, the only species in this genus, is found along the banks of cold streams of the Coast Mountains from Northern California to the Olympic Peninsula (2). Counts were made on the cells of 12 individuals taken mainly in the zone of intergradation of the two subspecies *olympicus* and *variegatus*, and at least 20 counts were made per individual.

The morphology of the haploid set reveals eight metacentric chromosomes and five submetacentric ones. If the chromosomes are arbitrarily divided into longer and shorter ones, the set can be formalized for this species as  $4M, 2S, 4m, 3s$ , where  $M$ =metacentric,  $S$ =submetacentric; the lower-case letters denote the shorter chromosomes of the set. The longest chromosome at anaphase II averages  $19 \mu$ , the shortest averages  $6.5 \mu$ . The ratio of the longest chromosome to the shortest for the haploid set is 2.9. Chiasma frequency was determined at diplotene of prophase I to have a mean of 39, with a range of variation from 36 to 42. The number of bivalents showing a minimum of two chiasmata was five. Figure 1 (top) shows the haploid set at anaphase I, and (bottom) the 13 bivalents at diplotene. As in other studies of the Caudata, no evidence for heterochromosomes was found in this species.

In addition to being of interest as a new chromosome number for the order Caudata, this finding allows for some speculation regarding the systematic position of the genus *Rhyacotriton*. While in some groups the chromosome number varies even among species of the same genus, this has not been true of the salamanders. If, as was stated by Matthey (3), "A chromosomal discontinuity corresponds to the familial discontinuity of the systematians; within the families the fundamental homologs of the chromosomes are respected . . ." it would seem that a taxonomic revision might be indicated. Perhaps this species belongs to a new and separate family. On the other hand, it may be that this merely represents an evolutionary offshoot not divergent enough to enjoy a separate family status but still indicating a genus rather remote from the main group of ambystomids. Other cytological and morphological evidence confirms the rather unique character of this salamander with respect to other ambystomids. In a similar situation in another family of Cau-

Table 1. Chromosome numbers in ambystomid salamanders.

Species	Haploid No.	Diploid No.	Investigator
<i>A. mexicanum</i>	—	28	Wickbom, others (1)
<i>A. tigrinum</i>	14	28	Parmeter; Carrick (1)
<i>A. maculatum</i>	—	28	Henley and Costello (6)
<i>A. jeffersonianum</i>	14	—	Kezer (7)
<i>A. gracile</i>	14	28	Humphrey (7)
<i>A. macrodactylum</i>	14	28	Humphrey (7)
<i>D. ensatus</i>	14	28	Humphrey (7)
<i>R. olympicus</i>	13	26	Humphrey

data, the Salamandridae, Fankhauser (4) found that American species of *Triturus* have a diploid chromosome number of 22, while European species and the Japanese *Triturus pyrrhogaster* have 24. All these species have been allowed to remain in the same genus, aside from the recent shift of the Pacific Coast species to the genus *Taricha* which was based on priority and not on cytological considerations (5).

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### Serum Diphosphopyridine Nucleotide Linked Enzymes in Delirium Tremens and Allied Conditions

During the past few years some transaminase and dehydrogenase enzymes as well as fructoaldolase (aldolase) in biological fluids have received considerable attention in various pathological conditions in man—for example, in myocardial infarction and in acute liver cell damage. These enzymes are widely distributed in the cells of the body, and the working hypothesis is that they are liberated into extracellular fluid in pathological conditions with localized or diffuse cell damage (necrosis) in certain tissues. The amounts of enzymes liberated are then approximately proportional to the magnitude of the tissue damage. The enzymes may be deter-



Fig. 1. Chromosomes of *Rhyacotriton olympicus* at meiotic anaphase I (top), showing 13 sets of sister chromatids, and at late diplotene of the meiotic prophase I (bottom), revealing 13 bivalents.



mined by measuring the change of absorbance at 340 mμ with time for the transformation  $\text{DPN}^+ \rightleftharpoons \text{DPNH}$  when DPN is part of the system or when it is coupled to such a system (1-3).

Liver damage is a common finding in alcohol addicts; either a lipomatosis or a cirrhosis of the liver is often found. The immediate cause of delirium tremens (DT) is unknown at present, but some similarities with liver precoma are obvious. To study whether there might be acute liver cell damage in delirium tremens, we have followed about 400 cases of DT and allied conditions with determinations of glutamic-oxalacetic transaminase (GOT) and also, in about 100 cases, of glutamic-pyruvic transaminase (GPT), malic dehydrogenase (MD), and aldolase in serum, during the acute stage of the disorder and in the convalescents. The patients have usually shown signs of a chronic liver disease, probably a lipomatosis, as measured by bromosulphophthalein clearance, prothrombin time before and after administration of vitamin K, serum bilirubin, bile pigments in urine, total lipids in plasma and others. Only in about 1 percent of the cases have clinical signs of cirrhosis been obtained.

Markedly elevated serum GOT levels are found in delirium tremens (4). The elevation is simultaneous with the mental and somatic symptoms, and a GOT peak is obtained at the height of these symptoms. When the delirious state is over, the GOT level usually reverts rapidly to low or normal values. The peak level is correlated with the severity of the delirium. Usually 200 to 1000 Karmen-Ordell units (3, 5) are found in severe cases and less than 300 units in mild and moderately severe cases, in syndrome B, and in syndrome C (see Table 1). In one case, a moderately severe delirium tremens and commotio cerebri without electroencephalographic changes, a peak level of 2900 units was obtained. When patients are admitted during acute alcohol intoxication, before a delirium has started, high GOT levels are also observed. The level then often reverts rapidly to low or normal values as the blood alcohol concentration decreases, but rises again if delirium tremens follows. In alcohol addicts a GOT rise is also often seen after a single day's drinking, even if a long period of abstinence with normal GOT level has preceded the incidence. Two periods of delirium were obtained for a few patients, and then two GOT peaks were found.

Serum GPT and aldolase are also elevated in delirium tremens and allied conditions. Glutamic-pyruvic transaminase is not raised as markedly as GOT. In general, a peak is obtained during the acute stage, but the ratio GPT:GOT

Table 1. Maximum values of serum GOT, GPT, and aldolase during delirium tremens and allied conditions in alcohol addicts. The terminology with respect to the acute (mental and physical) sequelae to alcohol abuse in alcohol addicts is confusing in the pertinent literature. We have classified these sequelae as follows (only the most important symptoms are given here) (4): Syndrome B: tremor, anxiety, perspiring, bad sleep or bad appetite, or both; no hallucinations or disorientation. Syndrome C: the same, but with hallucinations; no obvious disorientation. Delirium tremens (DT): tremor and other motorical symptoms, marked vegetative disturbances; hallucinations and disorientation; DT<sub>1</sub>, mild intensity; DT<sub>2</sub>, moderate intensity; DT<sub>3</sub>, severe intensity. Alcoholic delirium in geriatric cases (delirium tremens sine tremore): mild DT without tremor. In this table, Mild DT corresponds to DT<sub>1</sub> + DT<sub>2</sub> + geriatric alcoholic delirium; Severe DT corresponds to DT<sub>3</sub>.

Clinical group	No. of cases	Range of values	Mean and S.E.* of mean	S.D.†	Student's <i>t</i> test of significance‡	
					<i>t</i>	<i>p</i>
<i>Glutamic-oxalacetic transaminase</i>						
Normal	25	11- 35	21.6 ± 1.3	6.1		
Syndrome B	249	18- 348	81.6 ± 3.7	58.0	5.17	< 0.001§
Syndrome C	39	37- 500	115.0 ± 16.2	100.8	2.97	< 0.01§
Mild DT	151	16-2920	183.7 ± 20.0	245.6	1.71	< 0.1
Severe DT	22	228-1020	494.1 ± 56.0	262.6	5.87	< 0.001§
<i>Glutamic-pyruvic transaminase</i>						
Normal	24	5- 29	14.8 ± 1.2	5.8		
Syndrome B	67	4- 166	51.8 ± 5.3	43.0	4.18	< 0.001§
Syndrome C	11	23- 133	57.0 ± 12.1	40.1	0.12	> 0.9
Mild DT	52	19- 206	62.2 ± 5.0	35.9	0.43	< 0.7
Severe DT	7	100- 201	144.0 ± 15.1	39.9	5.59	< 0.001§
<i>Aldolase</i>						
Normal	24	5- 13	8.3 ± 0.4	1.8		
Syndrome B	67	3- 50	15.5 ± 0.8	6.9	5.05	< 0.001§
Syndrome C	11	6- 48	19.2 ± 3.6	11.9	1.47	< 0.2
Mild DT	52	6- 71	26.7 ± 2.0	14.7	1.59	< 0.2
Severe DT	7	19- 60	36.0 ± 5.9	15.5	1.56	< 0.2

\* S.E., standard error. † S.D., standard deviation.

‡ Comparison between pairs of clinical groups: normal versus syndrome B; syndrome B versus syndrome C; syndrome C versus mild DT; mild DT versus severe DT.

§ The difference of means is statistically significant.

is always below 1.0, which is contrary to the case with infectious hepatitis (6). Usually GPT does not exceed 100 units, except in severe delirium tremens; the highest level observed in severe cases was 200 units. Now and then zero level was obtained (no pyridoxal phosphate was added during analysis, but the patients were given vitamin B<sub>6</sub>). To control this finding, pyridoxal phosphate was added on analysis of serum from other delirium tremens patients, but without any significant effect on the GPT or GOT values. The aldolase level follows approximately the same course as the GOT level, but is more variable from time to time. Maximum values up to 80 Bruns units (2) are obtained. Malic dehydrogenase is also elevated during the acute stage, but is variable from time to time (mainly determined indirectly as GOT in serum without added MD, in percentage of GOT value with added excess MD) (5). In general, values below 80 percent are obtained, as in disorders other than myocardial infarction. In a few cases lactic dehydrogenase was also determined, but this enzyme was only slightly elevated in serum.

These findings suggest acute liver cell

damage in delirium tremens in addition to the chronic liver disease also observed. However, cell damage in other tissues such as skeletal muscle, heart, kidney, or brain cannot be ruled out as an additional cause of the raised enzyme levels in serum. In a few cases GOT was determined in cerebrospinal fluid. The values found were within normal limits (7).

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## Simple Tissue-Culture Technique for Quantitating Free Migration of Reticulo-endothelial Cells

This paper (1) describes a method for short-term, reproducible, quantitative measurement of the effects of experimental procedures on the migratory powers of reticuloendothelial cells in culture. Although splenic tissue was used in the preliminary work, the technique is adaptable for observations on mature and precursor motile cells in bone marrow and other organs.

A 5-mm length of woven Fibreglass sleeving is prepared by repeated washing in xylol, alcohol, water, dilute HCl, NH<sub>4</sub>OH, and double-distilled water. Its lower 1.5 mm is made into a well-type receptacle by filling its interstices and the lower end with Diatex. (Diatex is a tolulol solution of a transparent acrylic acid, plastic compound which hardens on drying and which can be autoclaved or sterilized in a heat oven. It has proved to be nontoxic in over 1200 tissue cultures.)

The prepared sleeving is attached along its length to a piece of cover glass (Fig. 1). In the developmental stage of this project, half of a spleen from a 12-day chick embryo, removed with the usual aseptic precautions, was used as test material. This piece of tissue is slipped into the open end of the Fibreglass sleeving, which with its attached cover glass is then placed in a Kahn tube containing 0.7 ml of supernatant, which consists of 0.25 percent human serum protein in Hanks' balanced salt solution. The Kahn tube is closed with a sterile serum-type rubber stopper containing a No. 20 hypodermic needle (fitted at its upper end with a cotton-plug bacterial filter).

Any free, nonmigratory, dead or damaged cells from the fragment of tissue

fall into the well-type receptacle at the lower end of the Fibreglass sleeving, where they are retained. Any living cells with migratory powers move actively through the interstices and enter the supernatant in the Kahn tube. After any desired interval of time, the cover glass with the attached sleeving is carefully withdrawn from the Kahn tube, and uniform suspension of the cells remaining in the supernatant and on the walls of the Kahn tube is obtained by vigorous shaking for 1½ minutes. (We assumed that the number of cells remaining on the sleeve and cover glass bears a constant relationship to the total number counted. No attempt was made to identify these cells. In the future, silicizing of the tube will eliminate this difficulty.) Enough cell suspension is removed to charge the counting chamber of a hemocytometer, and the number of cells per square millimeter is counted under phase-contrast microscopy. Alternatively, aliquots of supernatant can be removed from the tube at any time for counting (with subsequent restitution of the total volume of 0.7 ml of supernatant in the Kahn tube.)

Figure 2 shows the results of cell counts done at 12-hour intervals on over 50 such cultures. In the first 24 hours there is a sharp increase in the number of cells in the supernatant; during the second day there is much more gradual increase in the cell count; and during the third day in culture there is a sharp decline in the cell population. The curves for the individual cultures were similar to the composite one shown in Fig. 2.

Smears of the centrifuged supernatant, when stained by Wright's method, showed large lymphocyte-like cells and polymorphonuclear cells containing either eosinophilic or neutrophilic granules. Erythrocytic or other nonreticuloendothelial cells were not seen.

Much work has been done on the tissue culture of migratory cells (2, 3). In the past, changes in the numbers of these cells in culture have been followed by counts on all cells present (including damaged cells) or by complex histological or biochemical studies. Our method is simple, speedy, and economical. It can be used to measure the effects of experimental procedures (including screening of pharmacological agents) on a function of reticuloendothelial cells. It has all the advantages of previous techniques. In addition, whole organs can be used, and the anatomical structure of the organ is maintained. Experiments in which this system is used will involve a representative section of the whole reticuloendothelial system. Most important, the cells measured by this technique have shown themselves to be

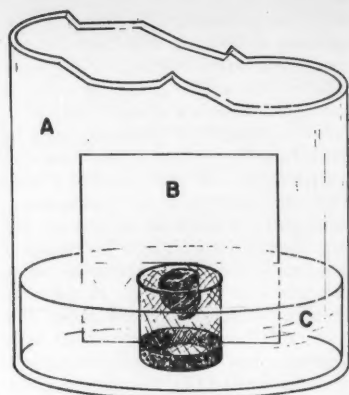


Fig. 2. Simplified diagram of culture assembly. A, Kahn tube; B, cover glass; C, Fibreglass sleeving with piece of spleen.

healthy in that they are capable of normal migration. This work also confirms the ability of cells in the spleen to migrate in a fluid medium.

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## Chemical, Insecticidal, and Antibiotic Properties of Fire Ant Venom

The imported fire ant (*Solenopsis saevissima* var. *richteri*) has become an insect of considerable economic importance in the southeastern United States. It has been reported to cause damage to a variety of crops and to attack livestock (1). This ant also attacks human beings. The reaction caused by the sting varies with each individual but is generally limited to the area surrounding the wound. An umbilicated pustule develops which is surrounded by a red halo or an edematous painful area (2). In some individuals, febrile and allergic systemic reactions have been reported. In at least one case, and possibly in two, reactions to ant stings have been fatal (2).

The nature of the venom of the imported fire ant has not been described. The necrotic activity and the characteristic pustule at the site of the sting indicate that the venom is different from any reported insect venom (2). We have

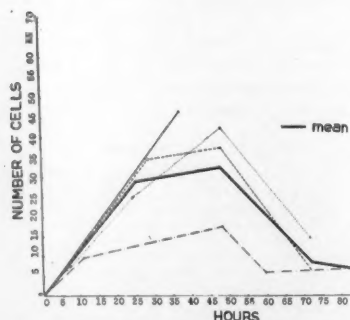


Fig. 1. Counts of migratory cells in supernatant as a function of time. Each curve represents the results from a series of 12 separate cultures, each point being the average of the measurements from three cultures. The heavy line represents the mean of the curves.

studied the chemical and physical properties of this venom and have found that it does not resemble the venom of any stinging insect previously studied.

Venom was collected from major workers taken in the field during the fall and winter. The ants were held by the petiole with a forceps while the tip of the abdomen was stroked with a fine capillary until the sting was everted. Droplets of venom issuing from the tip of the sting were collected in the capillary. The procedure was carried out conveniently under low magnification with a dissecting microscope.

The venom is water-insoluble, being less dense than water, in which it disperses as fine milky-colored globules. The absence of ninhydrin-positive reactants indicates it is nonproteolytic. The venom consists of two phases, primarily being composed of an alkaline carrier which suspends fine droplets of a greater density. The alkalinity of the mixture is not due to metal ions. These were determined to be absent by emission spectrographic examination in the Jarrell-Ash 4.8-meter grating spectrograph. The venom is soluble in most organic solvents, but least soluble in ethanol.

Ultraviolet spectrophotometric examination of the venom (in ethanol) in a Beckman DU spectrophotometer showed no peaks, absorption being strongest at the lower wavelengths. Infrared examinations (3) were made on a Perkin-Elmer model 21 spectrograph either as a carbon tetrachloride solution or as a film of venom applied directly to the rock salt prism. Only aliphatic C—H stretching was found (3.4  $\mu$ ), demonstrating the nonaromatic nature of the venom. A carbonyl group (5.70  $\mu$ ) is present which does not appear to be an open chain, simple ketone (4). Both methyl (7.25  $\mu$ ) and methylene groups are present as well as a possible ether linkage (8.6  $\mu$ ). The C—H/C=O ratio was found to be much higher when the sample contained small amounts of suspended globules. This indicates that the globular component contributes most or all of the carbonyl-containing compound.

Insecticidal activity was examined by exposing insects to residues, or by topically applying the venom as obtained from the ants. Samples for residual determinations were prepared as acetone or ethanol solutions. The venom was found to be highly toxic to the fruitfly, *Drosophila melanogaster* Meig., the housefly, *Musca domestica* L., a termite, *Kaleotermes* sp., the boll weevil, *Anthonomus grandis* Boh., and the rice weevil, *Sitophilus oryza* (L.). In addition, two species of mites, *Tetranychus telarius* L. and *T. cinnabarinus* Bois., were highly susceptible. Interestingly, the fire ant is not highly susceptible to its own venom.

The antibiotic activity of the venom

was investigated, and it was shown that several types of microorganisms were inhibited by a 1/50 dilution. Tests made by the paper-disk method demonstrated the effectiveness of this venom against *Micrococcus pyogenes*, *Streptococcus pyogenes*, *Escherichia coli*, *Lactobacillus casei*, and a variety of molds. The antibiotic activity of fire ant venom probably explains why the pustules arising at the site of the sting are antiseptic (2). A thorough study of the antibiotic properties is now being made.

The toxicities of different samples of venom to *Drosophila* have been found to vary, some samples being at least as toxic as DDT. Highly toxic samples of venom produce an instantaneous paralysis highly suggestive of a nerve poison. The most toxic samples contain a large percentage of the globular component, which suggests that this phase represents the toxic principle.

Recent work on the chemistry of ants has demonstrated the presence of a terpenoid lactone, iridomyrmecin (5), in various species of ants in the subfamily Dolichoderinae. Although these ants are in a phylogenetically more advanced subfamily than the fire ant (*Myrmecinae*) and do not have a functional sting, our infrared data suggest similarities in structure to this lactone. Iridomyrmecin also has been shown to have antibiotic and insecticidal activities (6). However, whereas iridomyrmecin produces tremors in insects suggestive of DDT poisoning (7), fire ant venom produces a sedative reaction, paralysis being unaccompanied by tremors.

The chemical composition of fire ant venom and the effect of it on malignant cells are being studied.

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## Methionine Inadequacy of Casein Hydrolyzate as Source of Difficulty in Vitamin Assays

The microbiological estimation of vitamins is undertaken routinely in many laboratories. Despite all efforts to maintain assay procedures under rigid control, it is not uncommon to encounter difficulty suddenly with methods that had been proceeding smoothly. Such occurrences are sometimes attributable to deterioration of one of the solutions used in making the medium, or, less frequently, to mutation of the test organism. In other instances, despite much searching, no reason for the difficulty can be found—then, suddenly, one once again obtains a satisfactory standard curve. Recent experience in this laboratory leads us to suggest that an unsuspected source of difficulty may be the variability in amino acid content of batches of commercial vitamin-free casein hydrolyzate (acid).

The routine analysis of folic acid by the AOAC method (1) with *Streptococcus faecalis* 29-21 [isolated by Harrison (2)] as the test organism suddenly failed, as evidenced by a very flat standard curve. Although the assay medium no longer supported the usual level of growth of *S. faecalis*, the organism still grew well on nonsynthetic inoculum broth. Doubling the concentration of certain batches of casein hydrolyzate in the assay medium resulted in improved growth, but the degree of improvement varied greatly from batch to batch.

The effect of supplementation of the folic acid assay medium with the following amino acids was studied: L-arginine · HCl, L-asparagine, L-cysteine · HCl, L-cystine, L-glutamic acid, L-histidine · HCl, DL-isoleucine, L-leucine, DL-lysine, DL-methionine, DL-serine, DL-threonine, DL-tryptophan, and DL-valine. For each amino acid, the amount added was that indicated by Greenhut *et al.* (3) to be necessary for the optimal growth of *S. faecalis*, American Type Culture Collection No. 8043. Only two of these amino acids produced any significant effect: the supplement of DL-methionine (5 mg/100 ml of double-strength medium) permitted normal growth of *S. faecalis*, while the supplement of L-leucine slightly improved total growth. The effect of leucine later proved to be due to contamination of this amino acid with 9 percent methionine.

The various batches of casein hydrolyzate were analyzed for methionine by the method of McCarthy and Sullivan (4), and the concentration of four lots on hand was found to be 0.15, 0.24, 0.30, and 0.38 mg of L-methionine per milliliter of hydrolyzate (10 percent casein). When the hydrolyzates were assayed by the microbiological method of Steele



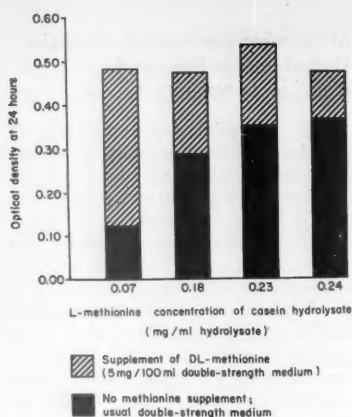


Fig. 1. Effect of methionine supplementation on total growth of *Streptococcus faecalis* 29-21 in folic acid assay medium. (Total growth occurring under conditions represented by 5 ml of double-strength medium and 10  $\mu$ g of folic acid, in a total volume of 10 ml.)

*et al.* (5), however, the corresponding values were 0.07, 0.18, 0.24, and 0.23 mg of L-methionine per milliliter of hydrolysate. The latter data were considered to reflect more nearly the true methionine concentrations than the former, when it was noted that off-colors sometimes resulted in the colorimetric procedure, particularly when certain samples were assayed at high concentrations. A direct relationship existed between methionine concentration of the hydrolysates and their varying abilities to support the growth of *S. faecalis* (Fig. 1), but even the batch of hydrolysate with the greatest methionine concentration did not contain enough to permit optimal growth of the organism.

In addition to the strain of *S. faecalis* used in this laboratory, a culture of *S. faecalis* 8043, the strain most commonly employed for folic acid analyses, was also studied. Similar results were obtained with this organism as with *S. faecalis* 29-21—that is, supplements of methionine resulted in improved growth, but the effect of methionine was not as marked as with *S. faecalis* 29-21, for the latter requires about 30 percent more methionine for maximal growth at 24 hours than does *S. faecalis* 8043. Even to meet the requirements of *S. faecalis* 8043 for optimal growth, however, Greenhut *et al.* (3) suggest a concentration of 0.25 mg of DL-methionine per assay tube containing 10 ml of single-strength medium. This is, in reality, a requirement of 0.125 mg of L-methionine per tube, since the D-isomer is utilized only slightly, if at all (6). With the usual concentration of casein hydrolysate of 0.5 ml/10 ml single-strength medium, the hydrolysate must contain 0.25 mg of L-methionine per milliliter of hydroly-

zate to provide the requisite amount, yet only two of the four hydrolysates tested approached this amount. It seems rather noteworthy that the reported (7) methionine content of casein of 3.3 g/16 g of nitrogen (equivalent to approximately 3 mg/ml of a 10 percent casein hydrolysate) exceeds by more than ten times the amount actually found in these hydrolysates, implying a rather extensive and somewhat variable loss of methionine during hydrolysis. To allow for this, it is now routine in this laboratory to supplement all folic acid assay medium with 5 mg of DL-methionine per 100 ml of double-strength medium.

It has long been recognized that methionine is an amino acid required by many common assay organisms. Thus, a deficiency of this amino acid would adversely affect a number of assays utilizing a variety of test organisms. Correspondence with the manufacturer of the hydrolysate revealed that no recent changes had been made in the manufacturing process and that the variability observed might be encountered under ordinary manufacturing conditions. The possible inadequacy of the usual amounts of casein hydrolysate in meeting the amino acid requirements of various organisms should, therefore, be considered as a source of difficulty with microbiological assays.

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#### "Root Pressure" in Gymnosperms

Movement of water to the tops of trees 200 or more feet high, in the large quantities which are required for normal growth and to replace losses by transpiration, involves the expenditure of enormous amounts of energy. There are two main theories current today of how this work is accomplished.

The one most widely accepted, the "suction tension theory" of Dixon and Joly (1) and of Askenazy (2) places the

energy expenditure at the surface of the leaf mesophyll cells in the form of heat of vaporization of water; vaporization sets up menisci in the porosities of the cell walls which in turn exert a tension against the water reservoir in the plant; this reservoir is pictured as being continuous through stem and roots with the water of the soil, and held against collapse by adhesion to the rigid framework of the plant's structure and by cohesion within the column. Water is thus pulled through the plant by the menisci at the leaf surface. The mechanical processes and structures involved require no active participation of the living protoplasts. Any accident which would break the column would destroy the effectiveness of the system.

Such a system can function only under conditions of (i) active transpiration, (ii) complete freedom from dissolved gases capable of causing cavitation and (iii) complete rigidity (freedom from shocks capable of breaking the adhesion of fluid to wall). Although this theory has a prominent place in present-day textbooks, its inadequacies have been pointed out repeatedly, most recently and forcefully by Scholander (3). Greenidge has also reviewed the subject (4).

The second theory postulates that energy is expended within the plant, probably in the root tips, endodermis and/or the medullary rays, against pressure gradients, comparable to the water-secreting mechanism of the mammalian kidney tubule which drives water back into the blood after its passive filtration in the glomeruli. Energy for this work would come from respiratory processes and would be independent of the physical phenomenon of transpiration, though affected by temperature, soil moisture, salt levels, carbohydrate availability, and other factors. Its immediate expression is the guttation which occurs from leaves on wet mornings and in the tropics where transpiration is reduced or lacking, and in the well-known exudation from cut stems. It was originally described by Hales (5) in 1727 and is commonly designated "root pressure."

Both mechanisms doubtless do operate, each under special conditions. Their relative importance in the water economy of plants is, however, still a subject of debate. Arguments against the importance of root pressure as a factor in sap movement have in general been three.

1) The observed pressures are generally too small to account for movements of water to heights of more than 30 or 40 feet. This argument was seriously weakened by the demonstration by White (6) in 1937 of secretion pressures exceeding 6 atm (about 200 feet) in single isolated tomato roots.

2) The amounts of water moved are



too small to account for the volumes involved in the transpiration stream, and root pressure cannot usually be demonstrated in transpiring plants. Although this argument is frequently raised, it is an obvious *non sequitur*. Transpiration, when it does occur, provides a mechanism capable of moving large quantities of water, but this can quite well occur independently of other mechanisms; they are in no way mutually exclusive; and the common methods so far devised for demonstrating root pressure require the abolition of the transpiration mechanism during the test. Scholander has recently introduced a method which does permit simultaneous demonstration of the two and has measured them simultaneously in certain vines (7, 8).

3) It has been stated, for example by Kramer (9), that "A . . . reason for doubting that . . . root pressure phenomena play an essential role in the intake of water, is the fact that it [root pressure] apparently never occurs in Gymnosperms. It would be very surprising if such a process were essential in one group of plants, yet not even occur in another [similar] group." And again, "Root pressure has never been observed in the Gymnosperms, and it is probable that active absorption never occurs in that group" (9, p. 790).

This last argument, if based on incontrovertible evidence, would indeed seem to make untenable any idea of root pressure being of general importance in the movement of water to the tops of tall trees.

On a suggestion from Scholander, made during the discussions at the Symposium on the Physiology of Forest Trees at the Cabot Foundation, Harvard Forest, Petersham, Mass. (Apr. 1957), we set out to examine the validity of this argument (10). Simple manometers were attached to the roots of three species of Gymnosperms: *Pinus strobus*, *Picea glauca*, and *Picea rubens* and, for comparison, on three Angiosperms: *Betula lutea*, *Populus alba*, and *Fraxinus americana*.

The procedure was as follows. Trees of as uniform age and size as possible were chosen, 15 to 20 feet in height, 25 to 40 years old. Roots were traced away from the trunk until branches 0.5 to 1.0 cm in diameter were exposed. These were severed perpendicular to the axis. Since such tissues, in actively transpiring trees, sometimes show negative pressures in the vessels, the roots were left for about 15 minutes to allow any air which might be sucked into the vessels by this negative pressure to come into equilibrium. A second cut was then made about 15 cm acropetal to the first so as to expose a new series of water-filled vessels, now in equilibrium. A rubber hose of suitable diameter was turned back upon itself for a distance of about

2 cm and was then placed on the root by rolling the everted portion on, so that the root tissues were not torn or bruised. A simple manometer of about 0.5 mm internal diameter was then attached to the hose and suitably supported in a vertical position. Readings of the height of fluid in the tubes were recorded at intervals from 11 July to 19 August 1957. It is to be noted that this is the driest part of the year, a season when transpiration is at a maximum and when positive sap flow is least likely to be evident, even in Angiosperms.

Of 51 manometers placed on roots of 17 coniferous trees, 24 (47 percent) showed positive sap flow. In 14 (27 percent) the columns developed were more than 40 cm in height. This was commonly the length of our manometer tubes, and greater heights could be read only by splicing on further tubes. In 13 cases such additional tubes were attached and flows up to 80 cm were recorded. In one case a mercury column was added, using a horizontal "S" connection and a mercury rise of 4 cm, equivalent to about 55 cm of additional water, to a total of about 70 cm, was recorded. In eight cases flow over the top of the manometer occurred, and the fluid was lost. In one case a flask was attached and 30 ml of fluid were collected. This was on a red spruce root (*Picea rubens*).

Under comparable conditions, the maximum flows observed from Angiosperm roots were 100 cm (*Betula alba* and *Fraxinus americana*). It is significant that no flow was observed in either Gymnosperms or Angiosperms growing on dry soil, whereas flow was observed in trees growing in moist locations.

From these experiments it is clear that, contrary to previous statements (8) active water secretion and "root pressure" do exist in Gymnosperms and can be demonstrated in several species under the conditions in which they are demonstrable in Angiosperms. Angiosperms do not, as has sometimes been suggested, occupy a unique position in this respect. The supposed absence of root pressure in Gymnosperms is not a valid argument against the general significance of root pressure in the water economy of plants.

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10. The work presented here was carried out as part of the Jackson Laboratory's program of training in research for secondary-school students, during the summer of 1957.

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## Effect of Transverse Atmospheric Drag on Satellite Orbits

In considering the various factors which influence the orbits of earth satellites, it is obvious that the motion of the earth's atmosphere, rotating with the earth, will tend to deflect the motion of the satellite. An approximate formula may be devised very simply to indicate the maximum perturbation caused by this effect.

When a satellite enters the atmosphere, the relative velocity giving rise to the air resistance, or drag force, is the resultant of the orbital velocity and the rotational velocity of the atmosphere. For any orbit not in the plane of the equator, the drag has a component transverse to the orbital motion, tending to deflect the motion and thus to change the plane of the orbit.

To derive an approximate formula for the maximum change to be expected, we make two simplifying assumptions: (i) that the plane of the elliptical orbit is parallel to the polar axis of the earth (a polar orbit); (ii) that closest approach (perigee) always occurs at the equator (actually, the position of perigee would change progressively for a polar orbit; for exact calculations suitable averaging factors must be included); (iii) that the satellite is spherical (actually, if it were finned so as to head into the relative wind, or if it tumbled at random, the averaged results would be the same as far as the total orbit change is concerned).

No assumptions need be made with regard to the magnitude of the drag or its dependence on velocity. The ratio of the component of drag,  $D_t$ , transverse to the orbit and the component,  $D_o$ , parallel to the orbit, will be the same as the ratio of transverse and orbital components of the relative wind velocity,  $v_e$  and  $V_o$ . That is:

$$D_t/D_o = v_e/V_o \quad (1)$$

where  $v_e$  is the cross-wind due to the earth's rotation.

On each revolution, the satellite suffers a small change in velocity,  $\Delta V$ , due to drag (primarily near perigee) and a corresponding change in momentum,  $\Delta MV$ .  $\Delta V$  and  $\Delta MV$  may be separated into components  $\Delta V_o$  and  $\Delta MV_o$  parallel

to the unperturbed orbit and  $\Delta V_t$  and  $\Delta MV_t$  transverse to them. Let  $\Delta\theta$  be the angle by which the velocity is deflected. This will be

$$\Delta\theta = \Delta MV_t / MV_o \quad (2)$$

since  $\Delta V$  is small. But the change in momentum is proportional to the product of the force acting and the time during which it acts, so that

$$\Delta MV_t = D_t \Delta t \quad (3)$$

and

$$\Delta MV_o = D_o \Delta t, \quad (4)$$

where  $\Delta t$  is the time during which the forces act.

From Eqs. 1 and 3

$$\Delta MV_t = \frac{v_e}{V_o} D_o \Delta t, \quad (5)$$

or, by Eq. 4,

$$\Delta MV_t = \frac{v_e}{V_o} \Delta MV_o, \quad (6)$$

so that, substituting Eq. 6 in Eq. 2,

$$\Delta\theta = \frac{v_e}{V_o} \frac{\Delta MV_o}{MV_o} = \left( \frac{v_e}{V_o} \right) \left( \frac{\Delta V_o}{V_o} \right) \quad (7)$$

Since this deflection is assumed to occur near the equator, the orbit plane will be tilted by the same angle with respect to the equatorial plane, so that the orbit for the next revolution would not pass exactly over the poles. On each revolution, a similar effect occurs; but since the effect is small, we may assume that the polar orbit is approximately maintained and regard the equation as giving the total change in orbit inclination corresponding to any given change in orbital velocity, regardless of how many revolutions are involved.

Two further assumptions are to be made now, one with regard to the average orbital velocity, the other with regard to the fractional change of the velocity. We assume 18,000 mi/hr as a fair average and assume a change of 20 percent as a maximum value over the portion of the satellite's life during which elliptical orbit shrinks to a circular orbit. The transverse component of the relative wind velocity is just the earth's rotational velocity, taken as 1000 mi/hr at the equator. Then, over this phase of the satellite's lifetime:

$$\Delta\theta_{\max} = \frac{1000}{18000} = \frac{20}{100} = 0.01 \text{ radian or } 0.6^\circ \quad (8)$$

Somewhat more refined calculations, which take into account the inclination of the orbit and the progression of perigee, predict changes in orbit inclination of  $0.1^\circ$  to  $0.2^\circ$  from the original inclinations (of  $65^\circ$  and  $35^\circ$ ) for U.S.S.R. and U.S. satellites launched so far (over their lifetimes, but not includ-

ing the last revolution). Unfortunately, up to the time of writing, the observational data published on orbit inclinations have not been of sufficient accuracy to check these predictions on the first two U.S.S.R. satellites. Because of the smallness of this effect it is unlikely that it can be used to obtain any definite information on winds and tides in the upper atmosphere.

Although the transverse atmospheric drag effect is seen to be small throughout most of the satellite's lifetime, it becomes of major importance in the last few thousand miles of the final revolution, when the velocity decreases from around 17,000 mi/hr to some lower value at impact. For all satellites so far put in orbit, the mass-area ratios are such that the satellites may be expected to lose substantially all forward relative velocity in the lower atmosphere, and to fall nearly vertically before impact, if they withstand the frictional heating without burn-up.

As a simple case, consider impact at the equator. The "orbital" motion, just before impact, will be in the plane of the equator. Therefore, the change in orbit inclination will be equal to the initial inclination, whatever its original value.

Only large meteorites or satellites having mass-area ratios many times larger than present satellites would be expected to have any appreciable residue of forward velocity at sea-level impact. Even for these,  $\Delta\theta$  would be a major fraction of  $\theta$ , as may be calculated roughly by applying Eq. 7 in several steps over the velocity range.

Perhaps it should be pointed out explicitly that  $\Delta\theta$  is measured with respect to the initial orbit plane, fixed in space. From the moon, for instance, the curvature of the orbit path would be observable. To an observer stationed at the equator on the projected track of the orbiting satellite, no such curvature would be apparent. Neglecting the small change of the atmospheric cross wind with latitude near the equator, the apparent course of the satellite in polar orbit relative to the observer on the equator will be slightly westward, as the result of the orbital velocity and the rotational velocity of the earth's surface. The satellite will stay on this course, relative to the (rotating) observer, regardless of the time-velocity history along the course, since both the transverse and orbital components of velocity change proportionately with the decrease of the resultant. The observer will note only the slowing, and the change of motion from horizontal to nearly vertical. The satellite would arrive at the point of impact several minutes later than it would have passed over had it not been slowed or stopped by the atmosphere. During this delay the earth's revolution

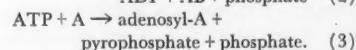
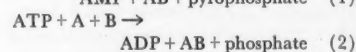
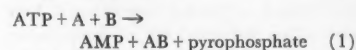
would move the impact point many miles, but this motion is, of course, not apparent to the earth observer.

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16 June 1958

## Role of Magnesium in Enzyme-Catalyzed Syntheses Involving Adenosine Triphosphate

Adenosine triphosphate or one of the polyphosphates with which it is in equilibrium (guanosine, cytosine, and uridine triphosphates) is a reactant in each of a large number of enzymatic syntheses (1, 2), and these ATP- (3) or polyphosphate-dependent syntheses account for the preponderant proportion of all known biosynthetic reactions. These reactions fall into one of the following three categories (4):



Regardless of the category, all known ATP-catalyzed reactions show an absolute requirement for magnesium ions (2). Other divalent metals such as  $\text{Mn}^{++}$  or  $\text{Ca}^{++}$  may replace  $\text{Mg}^{++}$  in some cases, but the maximal activity which these ions induce may equal but never exceed the maximal activity which obtains in presence of  $\text{Mg}^{++}$ .

Since a very wide spectrum of synthetic reactions is encompassed by ATP-dependent enzymatic processes, the universal requirement for magnesium ions undoubtedly reflects some important underlying chemical principles. This report deals with several considerations which may throw light on these principles.

Magnesium ions chelate rapidly with ATP (5), polyphosphates (6), phosphoric esters, inorganic phosphate, hydroxy acids (7), amines (8), and amino acids (9) under physiological conditions. Thus all the reaction partners in known ATP-dependent reactions are capable of chelation with magnesium ions. The effect of magnesium chelation in such reactions is to lower the free energy of activation of the rate-determining step. This is accomplished in two ways—first by lowering the heat of activation of the reaction, and second by virtue of a stepwise mechanism that eliminates the unfavorable entropy of activation in the rate-determining step.

The manner in which chelation of the reactants with magnesium ions reduces the heat of activation has been well discussed by others (10). Essentially, mag-

nesium ion lowers the heat of activation by acting as a generalized acid catalyst.

However, chelation of the reactants by the magnesium in the enzyme is certainly also important in eliminating the unfavorable entropy of activation in the rate-determining step. For reasons given below, the entropy of activation term may be even more important in ATP-dependent reactions than in most non-enzymatic reactions.

The entropy of solvation is more negative for charged ions than for neutral molecules. Therefore, when neutralization of charge occurs during the formation of an activated complex, the entropy increases and the reaction is favored. The reaction is also favored if the charge is spread during the formation of an activated complex.

Solvation effects are little if any help to ATP-dependent reactions. Reactants in ATP-dependent reactions are commonly not charged at the reactive position. The charges present elsewhere in the molecules are usually of the same sign (negative) in both reactants. This causes the activated complex to be more highly charged than either reactant. In these reactions the entropy of solvation strongly hinders the reaction. For example, let us consider the displacement of AMP from AMP-OAc by an attack of the sulfhydryl group of coenzyme A on the carbon of the carbonyl group of the acetate group in AMP-OAc. This reaction probably does not involve any charges at the point of reaction. In addition, both reactants are negatively charged elsewhere in the molecule. The entropy of solvation does not favor and probably hinders this reaction. This is true for many reactions in which the reactant is ATP.

We now discuss the entropy terms other than solvation that are important. When two neutral molecules A and B are brought together to form an activated complex  $AB^*$ , the greater number of translational degrees of freedom of the reactants than those of the activated complex (11) causes the entropy of ac-

tivation to be unfavorable (a decrease) for the process. Therefore, these entropy terms hinder all reactions.

The unfavorable entropy of activation may be eliminated by chelation. Chelation allows a stepwise reaction mechanism which eliminates the entropy terms in the rate-determining step, as is shown in Fig. 1. The dotted line refers to the reaction path without chelation, the solid line to the reaction path with chelation. The entropy of activation and the heat of activation would both occur during the rate-determining step in the absence of chelation.

When chelation obtains, the entropy of activation is taken care of in steps I and II (12) because this is when the reactants are gathered together. Thus, the heat of activation, which is now less, is the only terms which is important in the rate-determining step. The total free energy of activation of the reaction is thus less, so that the reaction is faster. We then see that reactants will react with a lower free energy of activation when they are both chelated to a common metal ion.

Looking at the problem in a different manner, we might consider the great stability of ethylenediamine chelates as compared with methylamine chelates. This difference is due primarily to the dissociation of the ethylenediamine chelates into fewer particles, giving therefore a smaller increase in translational entropy than that in the corresponding methylamine complexes (13).

The greater stability of the ethylenediamine complex over that of the methylamine complexes means that thermodynamics would favor the formation of a bond between the methyl groups of the methylamine complex. Although the reactions between methyl groups of methylamine complexes to give ethylenediamine chelates are impossible, were similar bond-forming reactions to occur in other systems they would tend to occur in the chelated rather than in the unchelated form.

The considerations discussed above are germane to reactions involving ATP. The usual reactants (coenzyme A, thiamine pyrophosphate, diphosphopyridine nucleotide, triphosphopyridine nucleotide, and ATP) are all molecules with pyrophosphate groups which provide handles for chelation. The reactions in which these molecules participate would require a metal chelator with a pyrophosphate specificity and a chelating strength which is intermediate between high and low. The intermediate chelating strength is necessary so that the products may dissociate from the enzyme. Magnesium ion fulfills all these requirements and is the ion universally associated with ATP reactions.

Considering the ideas presented above,

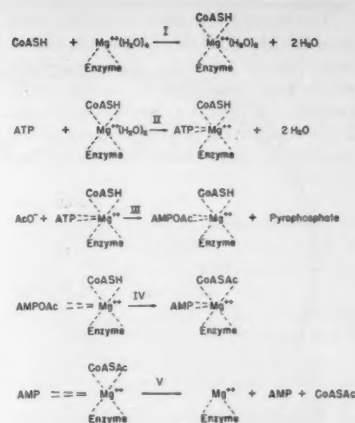
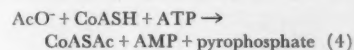


Fig. 2. A possible mechanism involving chelation by magnesium ions for the formation of acetyl coenzyme A. There is no significance in the order of occurrence of reactions I and II.

one may write a possible mechanism for reaction 4 which involves all six available coordination positions of magnesium, as is shown in Fig. 2.



The loss of entropy of translation of CoASH and ATP occurs in steps I and II, so that the reaction between these two groups (step IV) probably occurs with very little entropy of activation.

Step III, in which acetate ion displaces pyrophosphate ion, may not require chelation by the acetate ion. Here we have a small particle charged at the reactive position approaching to give an activated complex. The entropy of solvation may favor this reaction.

It is quite probable that one or another of the reactants is chelated much more strongly than another reactant. This situation could lead to inactive dichelates of ATP or perhaps CoASH. One of the important functions which the unique configuration of the enzyme fulfills is that of imposing such steric restrictions that only mixed chelates of ATP and CoASH are formed with the magnesium ion in preference to dichelates of ATP or CoASH.

Acetyl AMP has been shown by Berg (14) to give rise to acetate and ATP when it is incubated with acetic thio-kinase in presence of pyrophosphate and to give rise to CoASAc and AMP when it is incubated with the enzyme in presence of coenzyme A. Despite this powerful evidence that acetyl AMP is the intermediary in the acetate activation reaction, Berg and others have been unable to isolate or demonstrate acetyl AMP as an intermediary in the over-all reaction.

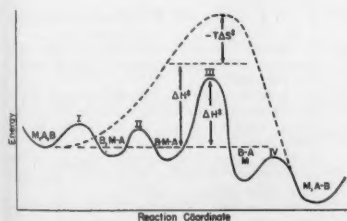


Fig. 1. The reaction path for the reaction of two molecules A and B with and without chelation by a metal M. The reaction path without chelation is represented by the dashed line, whereas the reaction path with chelation is represented by the solid line.



The acetate activation reaction serves as a model of ATP- and Mg-dependent reactions in general. The principles which have been applied to the model reaction are equally applicable to the large number of enzyme systems which catalyze the reactions described by Eqs. 1 to 3.

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3. The following abbreviations are used: ATP, adenosine triphosphate; ADP, adenosine diphosphate; AMP, adenosine monophosphate; A and B, various reactants; AMP-OAc, mixed anhydride of adenosine monophosphoric acid and acetic acid; AcO<sup>-</sup>, acetate ion; CoASH, coenzyme A; CoASAc, acetyl coenzyme A.
4. For an example of reaction 1, see H. Beinert, D. E. Green, H. Hift, R. W. Von Korff, C. V. Ramakrishnan, *J. Biol. Chem.* 203, 35 (1953); for reaction 2, see J. F. Speck, *J. Biol. Chem.* 179, 1405 (1949); for reaction 3, see G. L. Cantoni and J. Durell, *J. Biol. Chem.* 225, 1033 (1957).
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11. The entropy of translation is approximately proportional to the logarithm of the molecular weight, so that the translational entropy of AB\* is greater than either A or B but less than the sum of the entropies of translation of A and B.
12. Actually the free energy of activation of the chelation process may be quite largely composed of favorable entropy terms [R. G. Charles, *J. Am. Chem. Soc.* 76, 5855 (1954)]. The release of water molecules from the magnesium during the chelation more than makes up for the unfavorable entropy of bringing the reactants together.
13. See, for example, F. H. Westheimer and L. L. Ingraham, *J. Phys. Chem.* 60, 1168 (1956); C. G. Spike and R. W. Parry, *J. Am. Chem. Soc.* 75, 2726 (1953).
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23 May 1958

## Pigments in the Flower of "Fu-Yong" (*Hibiscus mutabilis* L.)

The pigments found in *Hibiscus* flowers are almost exclusively of the flavone type—that is, cannabiscitrin (*H. cannabinus* (1)), gossypin [*H. esculentus* (2)] and *H. vitifolium* (3)], gossypitrin, hibiscitrin, quercetin, sabbdaritrin (*H. sabbdariffa*) (4), and saponarin (*H. syriacus*) (5). As far as we are aware, the only *Hibiscus* flower known to contain anthocyanin pigment is *H. rosa-sinensis*. The deep red flower of this plant was reported to contain a delphinidin glycoside (6). Recent work, however, has revealed that the coloring matter of the flower is cyanidin diglucoside (7). We were much interested to find that no chemical work has been reported on the pigment in the beautiful flower of "Fu-Yong" (*H. mutabilis* L.), one of the most widely cultivated flowers in Chinese and Japanese gardens.

Since the outer petals of the flower are faintly pink colored, it was necessary to use a large number of flowers to get a sufficient amount of the pigment solution. The pigments of the flowers were extracted with ethanol hydrochloric acid, concentrated in a vacuum and hydrolyzed. Both paper chromatography and the color reactions of the isolated anthocyanidin fraction showed that its chemical constituent is cyanidin.

The outer petals (500 g) of the flower of *H. mutabilis* L. were repeatedly extracted with 0.01 percent ethanol hydrochloric acid. The combined extracts (500 ml) were concentrated in a vacuum at room temperature until no more solvent could be distilled out. After the concentrate had stood at room temperature for 4 days, the yellow-brown precipitate formed was removed by filtration. The filtrate (5 ml) was further hydrolyzed by adding 1.7 ml of 10 percent hydrochloric acid and refluxing for 30 minutes. (When the filtrate was hydrolyzed by adding the same volume of concentrated hydrochloric acid and boiling for 2 minutes, a large amount of black tarlike substance was formed.) The resulting brown precipitate was filtered, and the orange-red filtrate was extracted with isoamyl alcohol. The anthocyanidin in the isoamyl alcohol phase was transferred, by extraction with a mixture of 1 percent aqueous hydrochloric acid and benzene (1:1 by volume), into aqueous phase, and then again transferred into isoamyl alcohol phase.

Paper chromatography of the anthocyanidin solution was carried out by

using a mixture of glacial acetic acid, 36 percent hydrochloric acid, and water (5:1:5); the chromatograms were developed by the descending method (8). From the *R<sub>f</sub>* value of the spot (0.38) and the comparison of this value with the values of cyanidin [0.38, from red rose (9)], of pelargonidin [0.51, from *Pelargonium zonale* (10)], and of malvidin [0.44, from *Iris kaempferii* (11)], the anthocyanidin was found to be cyanidin. The extract of this spot (*R<sub>f</sub>* 0.38) also showed color reactions of cyanidin—that is, it turned red-purple on the addition of sodium acetate and blue on the subsequent addition of ferric chloride.

The brown precipitate obtained was extracted with ether. After the ether was expelled, the yellow residue was dissolved in ethanol. The solution turned to orange-red when it was treated with magnesium powder and hydrochloric acid, showing the existence of flavone (12, 13).

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13. We wish to thank K. Hayashi (Tokyo Kyoiku University) for his advice, and C. S. Hu (head, department of horticulture), Y. F. Shen (head, department of botany), and T. T. Wang (head, department of forestry of our university for permitting us to collect the flowers at their gardens.

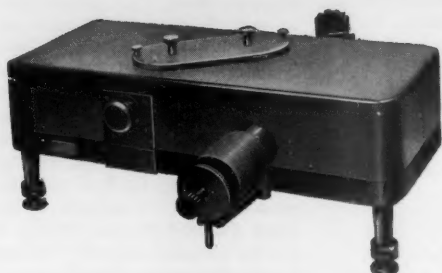
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## Meetings

### International Nutrition Congress

The Fifth International Congress on Nutrition, organized by the American Institute of Nutrition and the National Committee for Nutritional Sciences of the National Academy of Sciences, will be held in Washington, D.C., 1-7 Sept. 1960, under the auspices of the International Union of Nutritional Sciences. C. Glen King, executive director of The

Nutrition Foundation, New York, N.Y., has been named president of the congress; Elmer V. McCollum, professor emeritus of biochemistry, Johns Hopkins University, is honorary president. Paul György, professor of pediatrics, University of Pennsylvania, is chairman of the organizing committee.

In addition to papers submitted for the usual scientific sessions, a number of panel discussions and symposia on major problems in the field of nutrition in its broader aspects will be presented. There will also be scientific and industrial ex-

hibits. For additional information write to Dr. Milton O. Lee, General Secretary, 9650 Wisconsin Ave., Washington 14, D.C.

### Magnetism Conference

The fourth Conference on Magnetism and Magnetic Materials will be held in Philadelphia, 17-20 November, at the Sheraton Hotel. This conference is sponsored by the American Institute of Electrical Engineers in cooperation with the American Physical Society, the Institute of Radio Engineers, the Metallurgical Society of AIME, and the Office of Naval Research. Authors should submit abstracts by 1 September to the program chairman, H. B. Callen, Department of Physics, University of Pennsylvania, Philadelphia, Pa. Further details may be obtained from C. J. Kriessman, Local Chairman, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia, Pa.

### Applied Spectroscopy

The fifth Ottawa Symposium on Applied Spectroscopy will be held 15-17 September in the Lecture Hall, Victoria Museum, Ottawa, Ont. Any inquiries should be directed to Program Committee, Fifth Ottawa Symposium on Applied Spectroscopy, c/o Noranda Copper and Brass Limited, P.O. Box 1238, Place D'Armes, Montreal, Quebec.

### Nutrition Society of Canada

A meeting of persons interested in nutrition research was held in Ottawa on 7 October 1957 to discuss the formation of a nutrition society. A provisional committee was appointed to prepare a list of founding members and to draft a constitution. A formal meeting took place in Queen's University, Kingston, Ont. A membership of 90 was accepted, a constitution adopted, and the society was named the Nutrition Society of Canada. Membership is restricted to persons concerned with the scientific aspects of nutrition. President of the society is E. W. McHenry of Toronto. The society intends to hold annual meetings.

### 21st International Congress of Physiological Sciences

The 21st International Congress of Physiological Sciences will be held in Buenos Aires, Argentina, 9-15 August 1959. Bernardo A. Houssay is the president.

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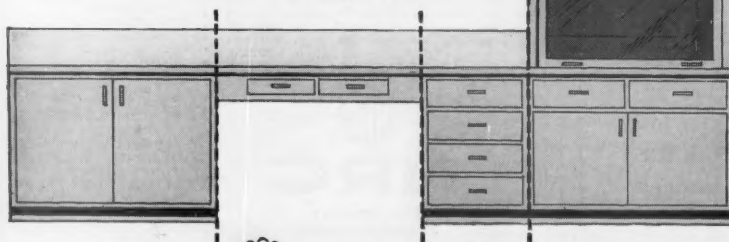
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to be held in the Southern Hemisphere, and to make it possible, many international and Argentine institutions are lending their financial support.

The deadline for the receipt of titles and abstracts of communications is 31 January 1959. The address of the secretary's office is 21st International Congress of Physiological Sciences, Facultad de Ciencias Medicas, Paraguay 2151, Buenos Aires, Argentina.

### Clinical Chemists' Meeting

The American Association of Clinical Chemists tenth anniversary meeting will be held on the campus of the State University of Iowa, Iowa City, 4-6 September 1958.

This will be the first meeting in the history of AACC devoted entirely to the interests of clinical chemistry, and it will also be the first national meeting to be organized completely by the association.

### Chemical Organization of Cells

A Conference on the Chemical Organization of Cells, Normal and Abnormal, will be held in Madison, Wis., 21-23 August. The meeting is being supported

by the National Institutes of Health as part of the program to increase the pathology research potential. For information, write to Dr. Joseph J. Lalich, Professor of Pathology, University of Wisconsin, 426 North Charter St., Madison, Wis.

The National Institutes of Health has made funds available to assist a limited number of workers in basic science fields to attend the Madison conference. This money will provide conference fees and up to a maximum of \$200 for transportation. In general, these funds are intended to support the travel and attendance of younger workers.

### Forthcoming Events

#### September

2-5. Alaskan Science Conf., 9th, College. (R. L. Rausch, Alaska Div., AAAS, Box 960, Anchorage, Alaska.)

2-5. American Physiological Soc., 10th autumn, London, Ontario, Canada. (APS, 9650 Wisconsin Ave., Washington 14.)

2-6. Engineering Societies, Pan American Federation, 5th, Montreal, Canada. (L. A. Wright, Engineering Inst. of Canada, 2050 Mansfield St., Montreal 2.)

2-6. Glaucoma, intern. symp., Liège, Belgium. (R. Weekers, Clinique Ophtalmologique, Hôpital de Bavière, Liège.)

3-5. Cryogenic Engineering Conf., annual, Cambridge, Mass. (K. D. Timmerhaus, Chemical Engineering Dept., Univ. of Colorado, Boulder.)

3-6. Blood Transfusion, 7th intern. cong., Rome, Italy. (G. Marinone, Clinica Medica, Policlinico, Pavia, Italy.)

3-10. Cybernetics, 2nd intern. cong., Namur, Belgium. (Association Internationale de Cybernetique, 13, rue Basse-Marcelle, Namur.)

4-5. Air Pollution, 2nd intern. conf., New York, N.Y. (American Soc. of Mechanical Engineers, 29 W. 39 St., New York 18.)

4-6. American Assoc. of Clinical Chemists, 10th annual, Iowa City, Iowa. (R. L. Dryer, Clinical Biochemistry Laboratory, State Univ. of Iowa, Iowa City.)

4-6. American Political Science Assoc., St. Louis, Mo. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

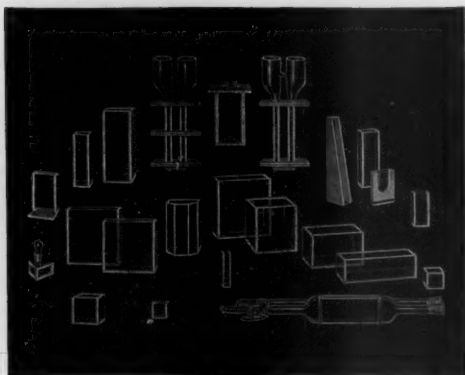
4-6. Calorimetry Conf., 13th annual, Lemont and Chicago, Ill. (D. H. Andrews, Dept. of Chemistry, Johns Hopkins Univ., Baltimore, Md.)

5-10. Formal Deductive Systems in Mathematics and in Natural Science, symp., Brussels, Belgium. (International Union for the History and Philosophy of Science, 4, rue Thenard, Paris 5<sup>e</sup>, France.)

5-13. Tropical Medicine and Malaria, 6th intern. cong., Lisbon, Portugal. (M. R. Pinto, Instituto de Medicina Tropical, Lisbon.)

6-12. Pharmaceutical Sciences, 18th intern. cong., Brussels, Belgium. (J. W.

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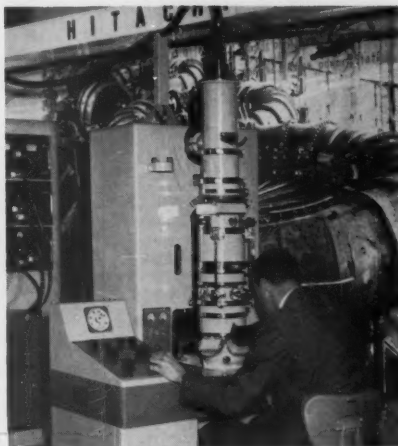
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*Cancer*, Jan-Feb 1956.

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Birza, 196 Bilderdijkstraat, Amsterdam W, Netherlands.)

7-10. Planetaria, symp., Bloomfield Hills, Mich. (J. A. Fowler, Cranbrook Inst. of Science, Bloomfield Hills.)

7-11. Diseases of the Chest, 5th intern. cong., Tokyo, Japan. (M. Kornfeld, American College of Chest Physicians, 112 Chestnut St., Chicago 11, Ill.)

7-12. Laurentian Hormone Conf., annual, AAAS, Blaney Park, Dallas, Tex. (G. Pincus, 222 Maple Ave., Shrewsbury, Mass.)

7-13. Hematology, 7th intern. cong., Rome, Italy. (S. Haberman, Baylor Univ. Hospital, 3500 Gaston Ave., Dallas, Tex.)

7-20. Industrial Chemistry, 31st intern. cong., Liège, Belgium. (Society of Industrial Chemistry, 28, rue Saint Dominique, Paris 7<sup>e</sup>, France.)

8-12. Spectroscopy Colloquium, 7th Intern., Liège, Belgium. (Association des Ingénieurs de l'Université de Liège, 22, rue Forgeur, Liège.)

8-13. International Council of Aeronautical Sciences, Madrid, Spain. (R. R. Dexter, Inst. of Aeronautical Sciences, 2 E. 64 St., New York 21.)

8-17. Sociology, 18th intern. cong., Nürnberg, Germany. (International Inst. of Sociology, Findelgasse 7-9, Nürnberg.)

9-11. Engineering Meteorology 2nd natl. conf., Ann Arbor, Mich. (K. C. Spengler, American Meteorological Soc., 3 Joy St., Boston 8, Mass.)

11-19. Conservation of Nature and Natural Resources, 6th general assembly, Athens and Delphi, Greece. (International Union for Conservation of Nature and Natural Resources, 31, rue Vautier, Brussels, Belgium.)

13-17. Bronchoesophagology, 7th intern. cong., Kyoto, Japan. (C. L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.)

14-20. Ceramics Cong., 6th intern., Wiesbaden, Germany. (Sekretariat des VI Internationalen Keramischen Kongresses, Reuterstrasse 235, Bonn/Rh., Germany.)

14-21. Cardiology, 3rd world cong., Brussels, Belgium. (F. Van Dooren, 80, rue Mercelis, Brussels.)

15-19. Instrument-Automation Conf., 13th annual, Philadelphia, Pa. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

15-20. Agriculture, European Confederation 10th anniversary, Vienna, Austria. (European Confederation of Agriculture, Pestalozzistrasse 1, Brugg, Argovie, Switzerland.)

15-20. Carboniferous Stratigraphy and Geology, 4th intern. cong., Heerlen, Netherlands. (Secretary, 4th Carboniferous Cong., Geological Bureau, Akerstraat 86-88, Heerlen.)

16-20. Nuclear Electronics, intern. symp., Paris, France. (Colloque Electronique Nucléaire, 10, avenue Pierre-Larousse, Malakoff (Seine), France.)

16-24. Glacier Movement Symp., Chamonix, France. (International Assoc. of Scientific Hydrology, 61, rue de Ronces, Genbrugge, Belgium.)

21-25. Differential Anthropology, 5th intern. cong., Amsterdam, Netherlands. (R. A. M. Bergman, Royal Tropical Inst., Linnaeusstraat 2A, Amsterdam.)

(See issue of 18 July for comprehensive list)

## Letters

### Monitoring of Foods

I heartily agree with Barry Commoner [*Science* 127, 1023 (1958)] on the necessity for more data regarding the basic facts of fallout. Because of the extreme complexity of the problem, a detailed understanding can result only from the analysis of very large numbers of samples derived from sampling networks providing intensive, as well as extensive, coverage of the world. One of the practical difficulties preventing the development of such a network has been the extreme difficulty of the radiochemical analysis for significant fission products which are present only to the extent of a small fraction of the natural radioactivity levels.

However, I wish to point out that the nationwide monitoring of foods is not as limited as his reference to the six-station network of the U.S. Public Health Service would imply.

Intensive effort at the Los Alamos Scientific Laboratory over the past 6 years has led to the development of large liquid scintillation counters which are capable of measuring and identifying changes as small as 10 percent of the natural gamma activity of people and foods in counting times of only 3 minutes per sample. Because of the large sample capacity (10,000 per year), the cost per sample is much less than that of conventional techniques. This system was placed in routine operation in the spring of 1956, and the results of the first year's operation were reported in *Science* [125, 1273 (1957)]. During 1956, 1133 measurements were made on people, including subjects from 29 states. The milk program included 168 samples from 11 states, and additional measurements were reported on meat and vegetables. During 1957, the milk network was expanded to include weekly or monthly samples from 31 locations within the United States and a few foreign countries. Eight hundred and eighty-seven milk samples were processed, and 820 determinations were made on people, including 311 subjects from 30 states. The total number of determinations was 2200, with the machine operating at about one-fifth its capacity. A preliminary report has been published [*Science* 127, 283 (1958)], and a more detailed report is in preparation. During 1958, the milk network has been further expanded, and over 1300 samples will be measured for their potassium-40, cesium-137, and barium-140 activities.

Now that the feasibility of such a foodstuffs monitoring program has been demonstrated, I join Commoner in hoping that other agencies, both state and national, will apply these techniques on



an even greater scale. Even with the cessation of weapon testing, similar systems of monitoring will be necessary because of the increased use of nuclear power reactors, whose potential production of fission products far exceeds the amounts of activity produced by bombs.

ERNEST C. ANDERSON  
Biomedical Research Group,  
Los Alamos Scientific Laboratory,  
Los Alamos, New Mexico

E. C. Anderson's comments regarding the feasibility of widespread monitoring of radioactivity in foodstuffs are encouraging evidence that it may now be possible to remedy "the lack of detailed, integrated, continuing data published in a form capable of enlisting the interest of the entire scientific community" that I pointed out in my article. Despite the very valuable contributions made by the Los Alamos group, the over-all situation on the radioactivity of food, especially with respect to strontium-90 in milk, remains rather confused. Anderson's laboratory has indeed produced extremely useful data which have been published in detail in *Science*. However because of the limitations of the bulk-counting technique, strontium-90 data are lacking. The Health and Safety Laboratory of the New York Operations Office of the AEC has studied at close intervals samples of milk from a half-dozen locations in the United States. The data are available in the form of a separate report, but most of the information does not appear in scientific journals. The results of the milk survey conducted by the U.S. Public Health Service were made public on 25 May 1958. In this case publication was in the form of a news release, and the data were restricted to an "average" for the 12 monthly analyses conducted at each of five locations. These variations in the form of publication and in the factual detail that is published illustrate the problem with which I am concerned. Surely the time has come when the agencies concerned with this problem should pool their data and publish them in detail in ordinary scientific journals.

BARRY COMMONER

Henry Shaw School of Botany,  
Washington University, St. Louis,  
Missouri

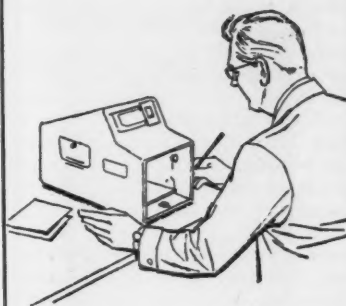
## U.S. and Soviet Science

Many an article has been published recently on Russian science and Russian education. Undoubtedly the training given the pupils of Soviet schools is far more advanced, in the field of science, than that offered their American coun-

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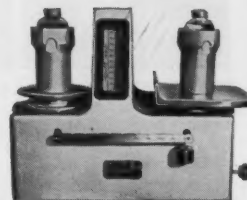
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terparts; Russian students enter their universities considerably better prepared than our high-school graduates enter American colleges and universities. It took the sputnik to shake the American public from its apathy toward education—science education in particular—and bring it to the full realization that we are lagging dangerously behind. Yet, already in 1954, I had pointed out that our educational standards, especially at the secondary level and junior-college level, were not on a par with those of many European nations. It was during that year, too, that, tempted by far better remuneration in secondary education, I taught a semester in an American high school. From this experience I always remember the words of our superintendent: "In America, we aim at making citizens, not at scholastic achievement"; and of a mother: "I shall not tolerate that homework—which should be done by right in school—invasades the privacy of my home and ruins my son's most precious possession, his eyesight."

The first disclosure of the Soviet advance upon us brought a clamor of dismay, then the search for an excuse: methods and programs in force in a dictatorship cannot successfully be applied in a democracy. Actually, is the Soviet pupil subjected to an intolerable educa-

tional and scholastic slavery? Nothing is further from the truth; strong secondary and higher education programs are in force in France, in Germany, and in Belgium, all very democratic countries. Throughout high school the Russian student spends 33 hours per week in school, of which 15 hours are devoted to science, and his Belgian counterpart spends, per week, 37 hours in school, of which at least 12 hours are spent on science and mathematics.

*Science* published recently [126, 1095 (1957)] an extremely interesting report on Soviet science. This article pointed out the unusual achievements and attainments of the various scientific disciplines, and I am deeply impressed by this information. The two fields which retained (quite naturally) my attention most specifically were oceanography and crystallography. The writers did some excellent reporting and clearly indicated that the Soviet Union is undeniably among the leaders. However, the emphasis put on the difference between what is done in the U.S.S.R. and in the United States perhaps creates an inaccurate impression: that we are trailing only the Russians. I wish here to underline that such is not the entire truth.

Facilities for oceanographic research in the United States—regardless of the

excellent results attained by such men as Ewing, Heezen, Shephard, and many others—do not seem to weigh heavily by comparison with facilities and equipment in the U.S.S.R. But, shouldn't we point out that the French have made just as tremendous strides? Although student enrollment is minimal, the University of Paris has inaugurated a brand new oceanographic station near Nice, has its own small vessel (the *Francis-Boeuf*), and calls upon the *Calypso* to supplement it, while the University of Aix-Marseille is famed for its work with the bathyscaphe.

In the article cited above, J. D. H. Donnay mentioned the amazement of Western scientists at the advances made by the Russians in the domain of crystallography and pointed to the status of this science in the United States: no institute of crystallography, a singularly great paucity of courses, and not one single department of crystallography in existence. The importance accorded crystallography in the realm of the geological sciences is not limited to Russia, and we are not trailing only that country. Belgian universities all have separate chairs of crystallography (as do the Russian) and require from all students aspiring to a master's degree in geology at least one course in crystallography, and the University of Louvain even imposes a requirement of one such course for the bachelor's degree and a second one for the master's [see R. H. Charlier, "The training of geologists and mineralogists in Belgium," *J. Geol.* 5, 2 (1957)]. Courses in crystallography are included in the curriculum of geological engineering; they are offered to students in physics and chemistry. This is also a required subject for would-be geologists in Switzerland. Every single Belgian university has a separate department of crystallography, and a student wishing to obtain his master's degree in geology may, if he so desires, specialize in crystallography and write his master's thesis in that field. In France, most of the universities have a separate department of crystallography, and in Paris alone, courses and departments exist at the Sorbonne, the Institut Catholique, and the Muséum d'Histoire Naturelle.

While perhaps Belgian specialists are not as advanced as their Russian counterparts (I am in no position to judge), I should mention that courses are offered and that people are trained in crystal chemistry and x-ray diffraction in Belgium.

It is thus apparent that we not only need to compare our achievements with those of the Soviets but should strive to emulate some other democracies as well.

ROGER H. CHARLIER

Laboratories of Physical Geography,  
Dynamic Geology, and Oceanography,  
University of Paris, France

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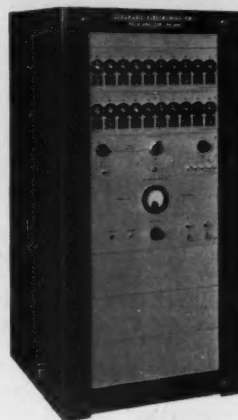
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**TIME INDICATING TUBE** is available in full-scale ranges of 250 to 5000 hr. Elapsed time measured by the tube is read with a commercially available colorimeter. The tube operates over an ambient temperature range of 0° to 100°C. Current drain is 1 to 100  $\mu$ a d-c, and voltage drop is approximately 2. The tube can be mounted in any position. (Raytheon, Dept. 228)

**URANIUM FLUORIMETER** is a transmission-type instrument. Its range is  $10^{-9}$  to  $10^{-5}$  g of uranium. With special care, levels below  $10^{-9}$  g may be measured. Readings are obtained from a digital dial. An attachment for liquid samples may be used with the instrument for the determination of beryllium, aluminum, and other substances. (Ball Brothers Research Corp., Dept. 234)

**SPECTRUM ANALYZERS** are offered in two models, one employing magnetostriction filters, the other crystal filters. In the first, the signal to be analyzed is applied to 100 filters simultaneously. Output of the filters is scanned by a high-speed capacitance commutator. Bandwidth is 32 cy/sec. The range from 50 to 10,500 cy/sec is covered in three parts. The second analyzer is a heterodyne type which separates 4-kcy/sec

## Low cost multi-channel PULSE-HEIGHT ANALYZER



20 channels  
100 spectrum points  
**\$4840**

### FEATURING:

- \* Building Block Design — can be expanded as desired
- \* 10 to 50 channel capacity
- \* 5 digit direct readout
- \* Excellent stability & resolution
- \* Window amplifier system yields 50 to 250 spectrum points
- \* Simplified operation—easy to maintain

The Eldorado Model PA 400 brings multi-channel analysis within the budget range of even the smallest laboratory. Expandable from 10 to 50 channels, the building block design enables the user to purchase a basic instrument and add additional 10-channel increments as needed.

The window amplifier circuit provides for a continuously variable selection of any 20v segment of spectrum under study. With this design up to 5 times the number of data points as there are available channels can be obtained.

By adding an Eldorado Model TH 300 Time-to-Pulse Height Converter, the above system becomes a Time-of-Flight Spectrometer and a Milli-microsecond Time Interval measuring device.

### SPECIFICATIONS

INPUT PULSE RANGE: 5 — 105v  
COUNT STORAGE: 10<sup>5</sup> counts per channel  
CHANNEL STABILITY:  $\pm 15$  mv referred to the window amplifier input  
PRICE (f.a.b. factory):  
10 channels — \$3340.  
30 channels — \$6340.  
50 channels — \$9340.

Write for complete technical information.  
Address: department 57.

## Eldorado Electronics

2821 Tenth Street  
Berkeley 10, California



bandwidths up to 20 kcy/sec into 29 equal frequency bands. Bandwidth of the crystal filters used is 135 cy/sec. Filter outputs are scanned electronically. (Kay Electric Co., Dept. 246)

■ **SOLAR FURNACE** includes a fully automatic solar tracking system to maintain precise alignment of the parabolic collector with the sun. Temperature is adjustable up to 7000°F. Motor-driven remote controls are provided for sample positioning. Mobile mounting of the furnace permits its use in any convenient location. (Thermal Dynamic Products Inc., Dept. 247)

■ **LIQUID-LEVEL INDICATOR** is an optical device using a photoelectric level-sensing probe. Operation depends on the total internal reflection rather than on the transmission of light through the fluid medium. The repeatability is within 0.015 in. with response time in milliseconds. The probe may be operated over the temperature range of -65° to +250°F. Output current up to 10 amp is furnished. When it is installed in a pipe line, the unit can distinguish between liquid and gas flow. (Revere Corporation of America, Dept. 245)

■ **PULSE-HEIGHT SELECTOR** features three modes of operation: an integral mode for counting all pulses above a base line; a 0-to-10-v window mode; and an upper-limit mode which makes the window control a 0-to-100-v upper limit for counting pulses between lower and upper limits. Rise time of the linear amplifier is 0.15 µsec and maximum gain is 8000. (Technical Measurement Corp., Dept. 239)

■ **ELECTROMETER** is a dynamic condenser instrument designed particularly for measuring the radioactivity of soft beta emitters such as tritium, carbon-14, and sulfur-35. Samples may be gas, liquid, or solid. The range from 1 mc to 5 µmc can be measured without use of absorbers or dilution. The instrument may be used to measure continuously flowing gas. (Nuclear-Chicago Corp., Dept. 238)

■ **GREASE-WORKER** is a motor-driven device for preparation of samples of grease for measurement of consistency by the penetration test. The motor is automatically stopped upon completion of a preset number of strokes, from 1 to 100,000, on two grease-working cups. (Fisher Scientific Co., Dept. 248)

■ **MEMORY STORAGE UNIT** operates by charging selectively any one of 60 capacitors mounted on a rotating disk. The charging and pick-off may be continuous, or the disk-drive shaft may be indexed by a servomechanism. Maximum charging voltage is ±200 v d-c. (Industrial Control Co., Dept. 241)

■ **VACUUM CONTROL** is actuated by a thermocouple vacuum gage at any set point within the range of 5 to 500 µ-Hg. A contact-type meter is used which operates a relay to control pumping equipment. A constant-voltage transformer furnishes heater current to the gage. (Veeco Vacuum Corp., Dept. 244)

■ **SPECTRUM ANALYZER** is offered in frequency ranges from 2400 to 9600 Mc/sec. Accuracy is ±0.8 percent or ±1 Mc/sec. Display of the spectrum is presented on a 5-in. oscilloscope. Sweep-rate ranges from 3 to 30 cy/sec. Minimum frequency dispersion is 50 kcy/sec in. The spectrum amplitude display is linear. (Polytechnic Research and Development Co., Dept. 235)

JOSHUA STERN

National Bureau of Standards

## PERSONNEL PLACEMENT

**CLASSIFIED:** 25¢ per word, minimum charge \$4.25. Use of Box Number counts as 10 additional words. Payment in advance is required.

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Replies to blind ads should be addressed as follows:

Box (give number)  
Science  
1515 Massachusetts Ave., NW  
Washington 5, D.C.

### POSITIONS WANTED

Dental Scientist, age 34 wants position of responsibility in dental engineering research. Academic background in dentistry and engineering; 7 years' engineering research and design experience. Box 183, SCIENCE. 8/8

Microbiologist, M.A.; 5 years of research experience in immunology, chemotherapy. Available for suitable position in September. Box 177, SCIENCE. 8/8

Organic Chemist. Ph.D.; 6 years' research in industry; desires more basic research than is possible in small company. Medical Bureau, Burnside Larson, Director, 900 North Michigan Avenue, Chicago. X

### POSITIONS WANTED

Ph.D., Microbiology-Biochemistry; 5 years of industrial and academic experience, fermentation processes, chromatography, bioassay, manometric, and radioisotope techniques. Seeks industrial position. Box 179, SCIENCE. 8/8, 22

### POSITIONS OPEN

(a) Biochemist; Ph.D. experienced hospital biochemistry; work with pathologist, serve as liaison between pathologist, medical staff; 300-bed, fully approved hospital; Midwest city of 100,000. (b) Virologist; Ph.D., D.V.M. for university appointment; consider graduate microbiologist; long-term research project on human, animal virus relationships; to \$8000; East. (c) Chemist; M.S., or young Ph.D.; help plan new department to occupy all new laboratory facilities in expanding hospital, over 200 beds; 120,000 procedures yearly; stable Midwestern city of 40,000. (d) Bacteriologist; 350-bed general hospital; to \$6000 or better; Midwest. (e) Research Biochemist; active laboratory, 250-bed eastern hospital; city of 50,000. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Experienced Histology Technician, ASCP preferred. Supervise histology laboratory in large midwestern teaching hospital, train technicians, opportunity for research. Box 163, SCIENCE. tf

### PHARMACOLOGIST-Ph.D.

... with several years experience to head laboratory of ethical drug company. Challenging position. Opportunity for growth with expanding organization.

Box 188, SCIENCE

Tissue Culturist for cancer research in large eastern institution. Prefer person with bachelor's or master's degree. Box 189, SCIENCE. X

### POSITIONS OPEN

Associate Director. Leading manufacturer of biologicals, blood bank, and blood typing serums seeks M.D.; laboratory background essential; permanent position; excellent remuneration; no travel. Write to Knickerbocker Biologicals Inc., 300 West 43rd Street, New York 36, New York. X

Chemist, male, with B.S. degree in organic chemistry or biochemistry, to participate in analytical biochemical research in mental illness in hospital near Philadelphia. Write stating age, education, experience, and salary desired to P.O. Box 8507, Philadelphia 1, Pa. 7/25; 8/1, 8, 15

Immunologist-Virologist. New vaccine program of progressive eastern pharmaceutical manufacturer offers unusual opportunity for experienced M.S. to participate in team activities as scientific specialist with broad liaison and advisory responsibilities. Salary commensurate with experience plus outstanding employee benefit program. Send complete résumé. Box 190, SCIENCE. 8/15

### PHARMACOLOGIST PHYSIOLOGIST

Ph.D. or equivalent with experience and interest in the cardiovascular and autonomic nervous system. To supervise and conduct research in the Cardiovascular Section of the Department of Pharmacology. Please submit résumé to

Personnel Department

The Wm. S. Merrell Company  
Lockland Station  
Cincinnati 15, Ohio



## POSITIONS OPEN

Electron Microscopist. M.S. or B.S. with graduate training or research experience. Research problems of tissue culture; specimen preparation; electron microscope operation in research laboratory of general hospital. Newark, N.J. Salary open. Box 187, SCIENCE. 8/15

Ph.D. or M.D. Endocrinologist. Leading pharmaceutical company research group seeks experienced endocrinologist. East coast area. Salary open. Please write, giving experience, training, and salary required. Box 186, SCIENCE. X

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, \$1.00. Yearly (12 issues) membership, \$5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22 N.Y. ew

## UNIVERSITY OF ALBERTA HOSPITAL EDMONTON, ALBERTA, CANADA

Applications are invited for the position of Assistant Director of the Department of Clinical Laboratory Services. The duties will be concerned with the future development of the biochemistry laboratory service in the hospital, consulting and advising on clinical problems and research projects involving biochemistry and teaching. A teaching appointment in the University of Alberta Medical School, while not automatic with this appointment, is customary. There will be ample opportunity to carry on individual research. The qualifications required are a degree in medicine and special training and experience in biochemistry. Preference will be given to those holding the M.R.C.P. or F.R.C.P. or a doctorate degree in biochemistry. Male, age 30-40 preferred but not essential. Salary \$10,000-\$12,000 per annum.

Interested parties should apply to the Medical Superintendent, University of Alberta Hospital, giving full details and the names of two referees. 8/8, 15, 22

(a) Young Ph.D. in one of Biological Sciences interested in research in pharmacology; excellent opportunity for one who prefers small research organization; typical fields in which individual might be asked to work are pharmacology of new anticholinesterases, immunological problems connected with treatment of allergies, and action of certain drugs on the skin. (b) Instructor in Nutrition and Diet Therapy; master's degree required; position carries academic appointment; large university; Midwest. (c) Psychologist to establish psychology section under department of pediatrics, university medical school. (d) Sanitarian; degree in sanitary sciences, public health, or engineering; 3 years' experience required; foreign operations, major industrial company; \$10,000-\$12,000. (e) Technologist (ASCP), Bacteriologist (M.S.) or Parasitologist (M.S.); laboratory department, 300-bed general hospital, JCAH approved; foreign operations, major industrial company; \$9072. S8-2 Medical Bureau, Burnice Larson, Director, 900 North Michigan Avenue, Chicago. X

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## BOOKS AND MAGAZINES

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Editor: James H. Shaw

Price \$4.50, AAAS Members' prepaid order price \$4.00

240 pp., 24 illus., index, clothbound, 1954

This volume offers a comprehensive consideration of the present knowledge of the relation of fluoride ingestion to human health. The eminent qualifications of each of the 21 authors should inspire confidence in the unbiased authenticity of the contents.

AAAS

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8 August 1958

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President and Director

THE CHARLES RIVER BREEDING LABS.

Dept. B, Wilmington, Mass.

8 August 1958

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Circle below desired number corresponding to:

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231	232	234	235	238	239	241
244	245	246	247	248		

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used to indicate particular items available in order of appearance in advertise-  
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<input type="checkbox"/> 276	<input type="checkbox"/> 278	<input type="checkbox"/> 313, UI	<input type="checkbox"/> 313, UO	<input type="checkbox"/> 313, LO*
<input type="checkbox"/> 314	<input type="checkbox"/> 315, LI	<input type="checkbox"/> 315, LO	<input type="checkbox"/> 317, A	<input type="checkbox"/> 317, B
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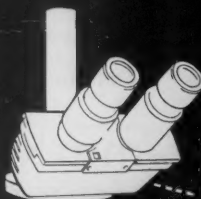
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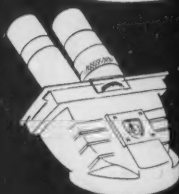


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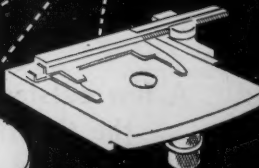
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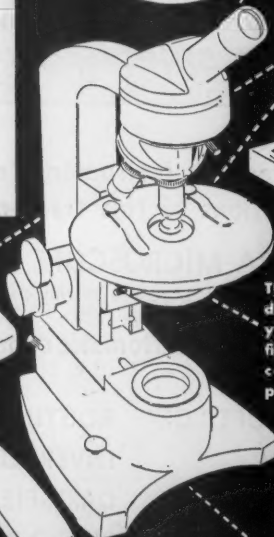
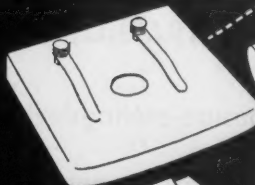
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